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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

MBA PROFESSIONAL REPORT

Combat Support Forces (1C6C) Naval Surface Forces Requirements-based Budget Determination for Assault Craft Unit ONE

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June 2009

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REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.			
1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** June 2009	**3. REPORT TYPE AND DATES COVERED** MBA Professional Report	
4. TITLE AND SUBTITLE: Combat Support Forces (1C6C) Naval Surface Forces Requirements-based Budget determination for Assault Craft Unit ONE			**5. FUNDING NUMBERS**
6. AUTHOR(S) Joshua P. Mock, Michael D. Ruminski, L. Scott Wallace			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited			**12b. DISTRIBUTION CODE**

13. ABSTRACT (maximum 200 words)

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14. SUBJECT TERMS Budget, Model, Requirements-based, LCU, ACU-1, 1C6C, NBG-1, OPTAR, Operational Availability			**15. NUMBER OF PAGES** 97
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UU

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

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COMBAT SUPPORT FORCES (1C6C) NAVAL SURFACE FORCES REQUIREMENTS-BASED BUDGET DETERMINATION FOR ASSAULT CRAFT UNIT ONE

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Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

from the

NAVAL POSTGRADUATE SCHOOL
June 2009

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TABLE OF CONTENTS

LIST OF FIGURES

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LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

Ao	Operational Availability
ACB-1	Amphibious Construction Battalion ONE
ACU-1	Assault Craft Unit ONE
ACU-5	Assault Craft Unit FIVE
ARG	Amphibious Ready Group
BMU-1	Beach Master Unit ONE
BOR	Budget OPTAR Report
CAPT	Captain
CDR	Commander
CESE	Civil Engineering Support Equipment
CLASSRON	Class Squadron
CMAV	Continuous Maintenance Availability
COMNAVSURFPAC	Commander, Naval Surface Forces Pacific
COSAL	Coordinated Shipboard Allowance List
COW	Cost of War
CSREP	Combined SR Expenditure Projection
DCM	Deployed Craft Model
DEI	Diesel Engine Inspection
DoD	Department of Defense
DON	Department of the Navy
DPMA	Dry-docking Phased Maintenance Availability
ENCM	Engineman Master Chief Petty Officer
FY	Fiscal Year
JFMM	Joint Fleet Maintenance Manual
LANTFLT	Atlantic Fleet
LCAC	Landing Craft Air Cushioned
LCDR	Lieutenant Commander
LCM	Landing Craft Mechanized
LCU	Landing Craft Utility
LFSP	Landing Force Shore Party

LHA/LHD	Amphibious Assault Ship
LOHM	Local Operating Hour Model
LPD	Amphibious Transport Dock
LSD	Dock Landing Ship
LT	Lieutenant
LTJG	Lieutenant Junior Grade
MCT	Mean Corrective Maintenance Time
MEU	Marine Expeditionary Unit
MDT	Mean Down Time
MTBF	Mean Time Between Failures
MTBM	Mean Time Between Maintenance
NAB	Naval Amphibious Base
NBG-1	Naval Beach Group ONE
OIC	Officer-in-Charge
O&M	Operations and Maintenance
O&S	Operations and Support
OMB	Office of Management and Budget
OPNAVINST	Naval Operations Instruction
OPSUM	Operations Summary
OPTAR	Operating Target
PACFLT	Pacific Fleet
POE	Projected Operating Environment
QM1	Quartermaster Petty Officer 1st Class
R^2	Coefficient of Correlation or Fit
RDT&E	Research, Development, Testing & Evaluation
RMC	Regional Maintenance Center
ROC	Required Operational Capabilities
SB	Depot-level repairables, OPTAR
SC	Consumable OPTAR
SEAL	Sea, Air, and Land
SLEP	Service Life Extension Program
SURFOR	Commander, Naval Surface Forces

SR	Repair OPTAR
SO	“Other” Consumable material OPTAR
SX	Administrative, Travel OPTAR
TEE	Total Expenditure Estimate
TQEE	Total Quarterly Expenditure Estimate

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ACKNOWLEDGMENTS

The authors would like to thank our families for giving support and understanding while working through this project, including Jenny, Kristy, Riley and Sydney. Mike Ruminski would like to thank his mother, Norma Ruminski, who passed away prior to completion of the project. We would also like to thank Professor K.J. Euske and Mr. John Mutty personally for their advice and encouragement during this project. A special thanks to Captain Brian Drapp, Julie Webb and Albert Pena for their direction and support, and to the staff of NBG-1 and in particular the staff of ACU-1 for their assistance in helping us gather and understand the information that allowed us to complete this project.

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I. INTRODUCTION

A. PURPOSE

The purpose of this project is to analyze the operational and maintenance requirements of Landing Craft Units (LCUs) in order to create a methodology for a requirements-based budget model for Assault Craft Unit ONE (ACU-1). The authors use the requirements-based budget model to explain past expenditures and attempt to classify and match future requirements to required resources to ensure the optimal level of readiness of the affected units. The model utilizes data obtained from the West Coast based units with the expectation that the model, with some adjustments, can be applied to the East Coast units.

The authors placed particular emphasis on determining the current level of operational availability (A_o). Another area of focus was to develop a better understanding of the actual requirements placed upon ACU-1 and how A_o both impacts those requirements and how those requirements impact the overall A_o. Finally, we examined funding levels and the impact that operations and other requirements have on the required funding level.

B. BACKGROUND

The Special Combat Forces Pacific is a specialized organization tasked with supporting Naval Amphibious operations conducted by the United States Navy and the United States Marine Corps. These forces on the west coast are organized under Commander, Naval Beach Group ONE (NBG-1) headquartered at Naval Amphibious Base (NAB), Coronado, California (U.S. Navy, 2008). NBG-1 consists of four subordinate commands: Assault Craft Unit ONE, Beach Master Unit ONE, and Amphibious Construction Battalion ONE also located at NAB Coronado and Assault Craft Unit FIVE located at Marine Corps Base Camp Pendleton, California (U.S. Navy, 2008).

Historically, the Special Combat Forces Pacific has been funded on an *ad hoc* basis. The Comptroller, Naval Surface Forces (SURFOR) has provided funds based on historical funding levels while offering extra funds based on availability. SURFOR provided these funds without a robust understanding of what is required to support the LCUs. Further, we have been unable to uncover any detailed documentation of ACU-1's current requirements that can be used to communicate to the SURFOR Comptroller to assist in the budgetary process.

While not an ideal situation, this process has provided the units of Special Combat Forces Pacific with sufficient resources to meet operational commitments. The concern is that in the coming years the weakening economy and large ongoing expense of the Global War on Terror could result in a significant tightening of SURFOR's resources, thereby affecting the funding levels of the Special Combat Forces. With limited information as to what the required funding level is for the Special Combat Forces, the SURFOR Comptroller has initiated the development of a detailed budget model to provide for a more effective management of funds. The budget documentation should provide justification to protect the necessary level of funds to support operations in the budgeting process and ensure that the requirements have been identified.

C. CONCEPT OF OPERATIONS

ACU-1 is based at Naval Amphibious Base Coronado in San Diego, California. ACU-1 operates 12 LCUs and four Landing Craft Mechanized (LCM) based in San Diego with four additional LCUs forward deployed to Sasebo, Japan (U.S. Navy, 2008). LCUs were designed in the 1950s and built during the 1960s to support ship to shore movement of combat forces and other equipment in support of amphibious assault and relief operations (Saunders, 2008).

ACU-1 organizes the craft into detachments of varying sizes of one, two, or three craft each. These detachments deploy as part of a Navy Amphibious Ready Group (ARG). An ARG is the Navy's component used in support of a Marine Expeditionary Unit (MEU). The centerpiece of an ARG is either an LHD (Landing Helicopter Dock) or and LHA (Landing Helicopter Assault) ship (U.S. Navy, 2007). The number of LCUs attached to either ARG is driven by a combination of factors. One factor is the desire of the ARG Commander. Another is the anticipated operations of the ARG while on deployment. A final factor that drives the number of craft assigned to each detachment is the centerpiece ship of the ARG. This ship, either an LHD or LHA, will impact the total number of LCUs that can deploy due to the differences in the configurations of the well decks. An LHD will normally deploy with two LCUs, while an LHA, will normally deploy with three LCUs in the ARG. However due to the total carrying capacity of the ships in the ARG the number of LCUs deployed with either ARG can be as many as five. The LHAs are in the process of being retired from service. Currently, there is only one operational LHA on the West Coast and three operational LHDs, with a new LHD scheduled to arrive on the West Coast later this year.

The LCUs provide the heavy lift capability to the Marine Landing Force with the ability to carry a maximum load of 170 tons (U.S. Navy, 2007). They are Diesel powered with a crew of 14, and are designed to conduct sustained operations at sea for up to 10 days (U.S. Navy, 2007). LCUs are similar to WWII-era landing craft with a bow ramp that is used for the disembarkation of units directly onto the beach. LCUs are outfitted with four .50 caliber machine gun positions and are the only landing craft equipped to conduct opposed landings against hostile forces (U.S. Navy, 2007).

D. LITERATURE REVIEW

The authors were unable to find any past research devoted to developing a requirements-based budget model. However, there have been several attempts in prior studies to develop Operating Target (OPTAR) allocation models for fleet units. These prior studies utilized regression analysis to determine if there was a link between OPTAR expenditures and operational schedules. Prior studies were able to show a relationship between levels of expenditures and a level of operations, but none of those studies attempted to include a specific operational requirement component to their model. Mills, Warner, and Rush (2008) attempted to analyze OPTAR expenditures among Ticonderoga Class Cruisers to determine if differences in those expenditures could be traced back to specific fleet requirements or homeport locations. Their research began by trying to explain the reasons LANTFLT units experienced lower expenditures compared to PACFLT units. What they found in their study was that neither a cruiser's age nor its configuration reliably predicted SO (Consumables) and SR (Maintenance) expenditures (Mills, Warner, & Rush, 2008). They did find that increased SX (Travel expenses) expenditures could be traced to a ship not being homeported in a fleet concentration area (Mills, Warner, & Rush, 2008).

Rysavy (2007) performed a statistical analysis of OPTAR expenditures for PACFLT Los Angeles Class Submarines in order to determine if there were any statistically significant differences in expenditures between homeport locations. Rysavy (2007) was able to show a relationship between OPTAR expenditures and ship schedules. This relationship was particularly strong for SR accounts, but weaknesses were noted in the relationship between SO accounts and ships schedules (Rysavy, 2007). In his analysis, Rysavy did not attempt separate the expenditures by individual unit, but rather grouped all units located at a specific location together.

Hascall et al. (2003) attempted to identify relationships between repair costs and level of operations. Using regression analysis, they were able to show a strong relationship between SR expenditures and operational schedules. This relationship allowed them to develop reliable predictions of past SR expenditures, but had little improvement in the ability to predict past SO expenditures (Hascall et al., 2003).

Brandt (1999) attempted to develop a parametric cost model for estimating O&S costs for non-nuclear ships. Using ship displacement, length, and manpower as independent variables Brandt, was able to develop a model that accurately estimated historic Operations and Support (O&S) costs (Brandt, 1999). His model could be used by a specific CLASSRON as a way to determine total CLASSRON year-to-year funding, but is not applicable to individual units.

Catalano (1988) developed an OPTAR allocation model that could be used to assist the COMNAVSURFPAC (now SURFOR) comptroller in the allocation of OPTAR grants to the fleet. In his model critical events in a ships schedule were used to forecast requirements by quarter (Catalano, 1988). This model proved reliable in being able to explain past expenditures. However, the model was only tested on two classes of ships and did not look at individual expenditures, instead the model, examined OPTAR total obligations without regard for fund code.

Kuker and Hanson (1988) attempted to develop a forecasting model for the distribution of OPTAR grants to units of SURFPAC. One of the weaknesses of their study was that age or equipment differences were not taken into account when they made their model (Kuker & Hanson, 1988). Their model might be of use to a specific CLASSRON, but its relationship to an individual unit is not strong. Kuker and Hanson (1988) did a good job of describing the budget formulation phase of afloat units. They point out budgets begin with taking the prior year funding level then making adjustments to this to this amount based on expected increases or decreases in expected expenses.

Williams (1987) performed an analysis of two classes of surface ships in the Pacific Fleet in an attempt to determine if relationships could be found between total OPTAR obligations and operational schedules. Using parametric and non-parametric statistical methods in his analysis, he did not find any statistically significant relationship between monthly total OPTAR obligations and operational schedules. There is no distinction made between SR and SO accounts in this study.

E. READINESS AND MAINTENANCE

The probability that a piece of equipment will be able to perform as it was designed in the actual operating environment can be described as readiness (Blanchard, 1998). Given this definition, readiness can be expressed as Operational Availability (A_O) (Blanchard, 1998). There are several variants to the basic A_O model as shown below in equations 1.1 and 1.2, but for the purposes of this paper the focus is on the basic up time/total time model.

Inherent Availability: $$A_0 = \frac{MTBF}{(MTBF + Mct)} \qquad (1.1)$$

Where MTBF is Mean Time Between Failure and Mct is Mean Corrective Maintenance Time (Blanchard, p.151, 1998)

Basic Formula: $A_0 = \dfrac{MTBM}{(MTBM + MDT)} = \dfrac{Uptime}{TotalTime}$ (1.2)

Where MTBM is Mean Time Between Maintenance and MDT is Mean Down Time (Blanchard, p.150, 1998)

Both of these models show the impact that reliability and maintainability have on readiness. In particular, reliability impacts MTBF and MTBM, while maintainability impacts Mct and MDT. Increasing the time between maintenance or decreasing the time that it takes to perform the maintenance can have a dramatic impact upon the overall readiness level of any piece of equipment.

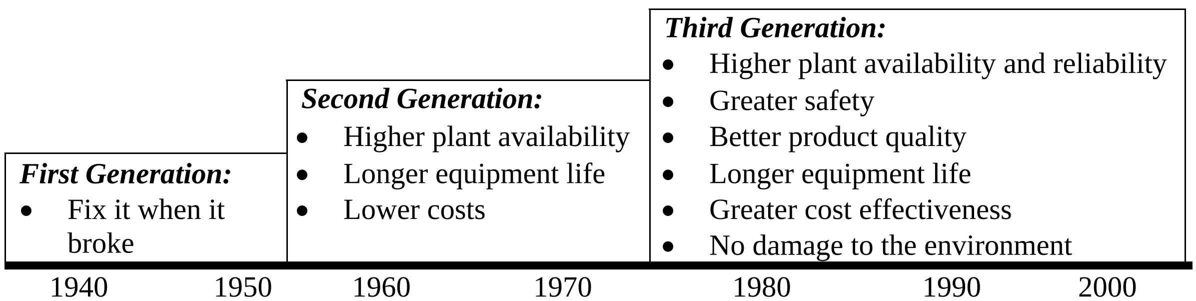

Figure 1. Growing Expectations of Maintenance (From: Moubray, 1997, p.3)

When looking at the availability of LCUs, it is important to remember that these craft have been around for the past 40+ years. Since the time that these units were built, the attitudes on readiness and maintenance have gone through a transformation. When LCUs were designed, a transition was underway from the First Generation to the Second Generation way of thinking about maintenance (Moubray, 1997). Figure 1 shows the differences between the first and second generation way of thinking about maintenance. First generation maintenance was to simply fix things as they broke with little or no analysis regarding what caused the equipment to break and the overall impact that this had on equipment availability (Moubray, 1997). Second generation maintenance involved more analysis of why things broke and this resulted in longer equipment life, increased equipment availability and lower total costs (Moubray, 1997). Figure 1 also shows the transformation that occurred in the expectations of maintenance between the

Second Generation and the Third Generation. The movement from the second to the third generation was the result of an increase in the use of improved management techniques (Mourbray, 1997).

Logisticians and managers have recognized the life cycle cost savings that can be found by improving system readiness (Blanchard, 1998). Because of this recognition money and effort has been spent in an effort to improve reliability, maintainability, and availability since the mid-1970s (Moubray, 1997). While Mourbray's depiction focuses on the changes that were occurring in industry, the same types of changes were occurring within the Department of Defense. In particular, within the military there was a recognition that readiness determines the number of any weapon system required to meet mission requirements. This recognition resulted in the realization that to improve readiness it is necessary to improve maintainability by reducing system down time or improve reliability by increasing the time between required maintenance (Blanchard, 1998).

F. IMPORTANCE OF BUDGETING

1. Definitions of Budgeting

There are multiple ways to define a budget, from what it does, to how it limits spending, to its affect on future planning. The Navy defines a budget as:

> …a document that expresses in financial terms the plan for accomplishing an organization's objectives for a specified period of time. It is an instrument of planning, performance measurement, decision-making, and management control, as well as a statement of priorities. Such a definition is descriptive of the Department of the Navy (DON) budget. (U.S. Navy, 2005, pp. I-2)

According to Aaron Wildavsky (1964),

> In the most literal sense a budget is a document, containing words and figures, which proposes expenditures for certain items and purposes... …a budget may be regarded as a contract… … concerned with the translation of financial resources into human purposes. (pp. 1-2)

In short, a budget is used to account for current spending, and to allot for future planning. Budgets have been used in the federal government since the signing of the Constitution. The Constitution states that Congress is "…to pay the Debts and provide for the common defense and general welfare of the United States…" (Constitution, pp. Art. I, Sect. 8) and is to provide such funds via "…Appropriations made by law…" (Constitution, pp. Art. I, Sect. 9). In order to meet its duties of appropriations and payments, Congress then developed a budget to properly allocate this money, and provide for future planning (Jones & McCaffery, 2008). These budgets tend to be incremental (Jones & McCaffery, 2008). As Jones and McCaffery (2008) argued the previous year's budget is used as the basis for next year's budget.

2. Budgeting in the Corporate World

Budgeting in the corporate world does not necessarily follow the same incremental approach as it does in the public sector. As noted by Dimmerling (1997), the corporate world begins the budgeting process by setting expectations for the upcoming year based upon key statistics or financial targets. As part of the process, it is important to understand how any variable cost activity is budgeted. The more accurate you can project your variable cost items the more accurate your budget will be (Dimmerling, 1997).

In 1995, Fleming wrote of the importance of budgeting. She states that "budgeting is one of the important planning and control tools used by managers…" (Fleming, 1995, p. 1). Fleming (1995) argues that every company should have a budget, regardless the size of the company. As part of the budgeting process, it is important that the leadership of the company establish the primary goals of the firm. In a for-profit company, the leadership must then develop a strategy to meet the goals that they have laid out for the company (Fleming, 1995). For organizations like the U.S. Navy, strategy must not only fit the goal of the larger organization, DoD, but is determined by the national security strategy, and ultimately, the President. In far too many cases, budgets are developed without taking into account the long-term consequences of how the budget will impact the ultimate goals of the company (Keogh, 2008). Keogh (2008) points out the importance of limiting the set of measures to determine the effectiveness of the budget. Keogh (2008), suggests the use of rolling budgets as opposed to the traditional calendar year fixed budget. This would require a change in the way the Navy, indeed the Government, prepares a budget.

3. Government Budgeting

In order to explain the budgeting process for ACU-1 and 1C6C, it is first important to understand the overall Federal budgeting process. The modern budget has changed much since the first days of the Union, as has the size of the Federal government. In addition to Appropriation bills that were first conceived of by the founding fathers, other documents are now required by law to successfully conduct government financial business year-to-year. These include the Authorization bill, the President's proposed budget, and other bills and documents. The Authorization bill provides direction on how the money given to a department is to be spent, and provides the legal authority to do so. The Appropriation bill actually directs the money to be distributed from the Treasury department to the various Federal agencies for spending purposes (Jones & McCaffery, 2008).

The President is required to present a proposed budget to Congress by the first Monday in February each year (U.S. Navy, 2005). The Office of Management and Budget (OMB) collects the budgets from the various departments within the government to provide data for the overall proposed Presidential budget. It is the responsibility of the departments, such as the Department of Defense, to plan their budgets to provide for sufficient spending for the proposed Fiscal Year (FY), as well as budgeting for future plans and expenditures. It is, therefore, incumbent upon the various components of the Navy to provide sufficient data and justification to ensure that their program receives the funds necessary for operation. Failing to complete this important task could result in a program being unable to complete its designated mission due to lack of resources (Jones & McCaffery, 2008).

Regarding the formulation of a budget, it is not as simple as merely listing the items that require money, and asking for the requisite funds. Careful consideration of both current and future requirements, as well as current and future funding levels must be taken into account when developing a budget submittal (Jones & McCaffery, 2008). It is probably reasonable to assume that all organizations would like to see what they view as their requirements fully funded. However, the reality is there are seldom sufficient funds available to cover every requirement. Therefore, building a budget around the highest priority items first and providing funds for the long-term projects of the highest value help ensure that the organization will sustain what is most important (Jones & McCaffery, 2008).

Another factor in the government budgeting process that must be considered is the type of funding that is requested and received (Jones & McCaffery, 2008). Department of Defense (DoD) budgets have multiple streams of money, such as Procurement, Research, Development, Test and Evaluation (RDT&E), and Operations and Maintenance (O&M) (Jones &McCaffery 2008). These funding streams are often referred to as different "color[s] of money" (Heberling & Kinsella, 1998, p. 2), referring to the different places the money comes from and the specialized uses of the money. For example, O&M money is used for day-to-day operations, and should not be used in new construction procurement, and likewise procurement money should not be used for personnel. Due to these different funding streams, it is critical that any organization that exists within the Navy maintain different budgets for different items, depending upon the type of item discussed and what money must be used to pay for it.

G. FUNDING ALLOCATION

Funding is provided to NBG-1 via the 1C6C budget category. In addition to these funds, NBG-1 has received Cost-of-War (COW) augments to fund expenses incurred in support of the Global War on Terrorism. The 1C6C funds are allocated by the SURFOR Comptroller to each of the units that make up NBG-1, such as ACU-1, to cover day-to-day operations in the form of an Operating Target (OPTAR) grant. The OPTAR grant is accounted for through various fund codes such as SR (Maintenance) and SC

(Consumables). Any increase to the initial OPTAR grant is received from either the SUFOR Comptroller in the form of budget augments or from COW augments. The OPTAR grant is also used to fund intermediate level maintenance that takes the form of Continuous Maintenance Availabilities (CMAVs). In addition, 1C6C funds pay for Dry-docking Phased Maintenance Availabilities (DPMAs). Generally, DPMAs are funded via the SURFOR Comptroller with the unallocated 1C6C money, which is sent directly to the Regional Maintenance Center (RMC). The authors found in their research that in FY07 and FY08 ACU-1 funded some DPMA expenses from their OPTAR grant and then the OPTAR was reimbursed via a COW augment.

H. METHODOLOGY

The method that the authors followed while conducting the research for this paper began with some basic assumptions. First, we assumed that OPTAR repair costs have some relationship to operating hours. Second, we assumed CMAV and DMPA costs remain fairly stable when taking into account inflation.

Given these assumptions, the focus became identifying the information necessary to determine measures of readiness and requirements placed upon ACU-1. U.S. Navy requirements documents were analyzed for assigned missions and estimated numbers of craft required for those missions. Planned maintenance and training requirements were validated and added to arrive at a total craft requirement. These figures were used in the determination of Ao.

Next, operating hours were calculated based on internal documents used by ACU-1. Two separate sources for operating hours were considered and compared for accuracy, Operating hours as recorded on weekly Operating Summary (OPSUM) reports and Diesel Engine run hours. Using operating hours as a base, it is possible to calculate the number of dollars per operating hour for a given level of readiness.

Financial data for the previous four fiscal years were then analyzed. The data were spot checked for accuracy and Naval Fund Codes were used to isolate the maintenance funds from the overall funding level. The funds expended on maintenance were then compared to operating hours to identify any statistically significant correlation between the two values.

As part of this analysis, interviews were conducted with maintenance and supply personnel to determine any funding shortfalls for the previous two years. Interviews were also conducted with the Commanding Officer of ACU-1 to gain an understanding of his views of the funding level. Interviews were also conducted with the Port Engineer and Operations Officer for ACU-1 to gain an understanding of the projections for the upcoming year.

This methodology is consistent with the recommendations of Dimmerling (1997) who recommends that the budget process must first start with the projections for next year. These projections take the form of changes in cost drivers and increases or decreases in the cost of items. Also of importance is Koegh's (2008) recommendation that you limit the number of items that you focus on to only those items that would account for the largest portion of total expenditures. Based upon a combination of Dimmerling's and Koegh's guidelines, the focus of this project became the SR fund code and its relationship to craft operating hours.

II. DATA COLLECTION

A. OVERVIEW

Data collection for the project began with a site visit to NBG-1 headquarters in San Diego. During the site visit, a command briefing was given by NBG-1's Commanding Officer. Members of this briefing included the Commanding Officers and selected staff members from each of NBG-1's subordinate commands. Because the scope of the project had yet to be defined, the authors were given an overview of each subordinate command's respective missions, capabilities, and basic financial status. Upon completion of the briefing the authors sat down with each subordinate command leadership team individually to ask more detailed questions and tour their facilities and see much of the equipment and craft that they used.

After receiving the general overview, the authors sat down with the project sponsor to evaluate the basic information that had been gathered and determine which command and platform offered the best opportunity to construct a requirements-based budget model. Based upon this meeting and the information from the interviews, it was determined that the focus of the project should be on the LCU platform from ACU-1. Reasons for this decision included the size of the budget in relation to the other commands, the amount of information that was available, and the operations of the LCUs being the best understood by the authors.

Once the subject of the project was determined, the authors had to make an initial assumption to limit the scope of the project. The initial assumption that the authors made was that ACU-1's costs are tied in some way to the number of hours ACU-1 operates its craft. This assumption is tied to the wear and tear that occurs in machinery and equipment as it operates, so as operating hours increase, more money will be required to maintain and replace broken parts. Given this initial assumption, the next course of action was to identify data elements that would best represent the money spent on operations and the amount of LCU use.

Next, the authors scheduled a meeting with a contractor for ACU-5. The contractor is a retired Naval Officer who has been involved with the LCAC program since its initial fielding (Tucker, 2009). In the years since his retirement, his primary task for ACU-5 has been the development of a budget model. The authors believed his experience would be a valuable guide for the development of the ACU-1 budget model. The discussions were limited to his methodology as it became apparent that the authors' would not be able to replicate the amount and quality of data used in the ACU-5 budget model. Utilizing the contractor's methodology as a base, the authors began to identify data that would best approximate the information the contractor incorporated into the ACU-5 budget model.

B. FINANCIAL DATA

Financial data for ACU-1 were requested from SURFOR in the form of the Budget OPTAR Reports (BOR). A BOR is a monthly report that is automatically generated by the supply inventory/budget management computer system during the end of month processing to present the current status of budgetary funds for a single line of accounting. The BOR lists the current OPTAR grant, the amount of the grant that has been obligated, and the Fund Code used for the obligation.

Fund Codes are a simple two-character code that serves as the Navy's way of breaking down obligations into a number of general categories to facilitate management of the taxpayer's money. The first character is a letter or number that denotes the administrative chain of command of the unit. The second character can also be a number or a letter and denotes the category of expenditure. A full list of fund codes and who they are assigned to can be found in Appendix 30 of the Naval Supply Systems Command Publication 485 Volume 2. (1997, U.S. Navy)

While there are many Fund Codes designated by the Navy, based on the authors' experience the majority of expenditures are covered by only a few. For ACU-1 the authors focused on SC and SR Fund Codes. SR represents funds spent on repair of machinery and equipment that is supported by the Navy's Coordinated Shipboard Allowance List (COSAL). These are essentially repairs to the LCUs themselves and the authorized equipment that the Navy has placed onboard. The SC fund code represents what the Navy calls consumables, which for ACU-1 is the largest segment of its spending. SC is essentially a catchall category, in that if another fund code does not directly apply to a purchase it will be made under SC. SC includes a wide range of material anywhere from pencils to a commercial handheld GPS system. While at first glance this Fund Code may not appear to be involved in the maintenance spending of ACU-1, it can also include contractor services for repairs and other outside/commercial maintenance support (U.S. Navy, 1997).

Additional data were also collected from the ACU-1 Supply Officer's personal record software. Supply Officers have generated *ad hoc* programs in Microsoft Excel or Access to help them analyze and verify their expenditure numbers in ways that are not available with the provided management system, Microsnap. ACU-1's Supply Officer utilized an Excel program, configured to maintain manual logs that detail the information reported on the BOR, OPTAR grants and transfers, and other financial products. This information was used to further the authors' understanding of ACU-1's financial data and to cross check the official records.

Background data were obtained from a previous Naval Postgraduate School Thesis titled "A Feasibility Study of Relating Surface Ships OPTAR Patterns to Their Operating Schedules" (Kuker and Hanson, 1988). This study was not conducted on LCUs specifically, but it contained a large amount of historical spending data by Fund Code. These data were used to compare assumptions made about LCU spending to other Navy platforms and give a basis for their validity.

The final piece of financial data was obtained from the ACU-1 Port Engineer. He provided the authors a list of DPMAs, including associated costs, conducted on LCUs from Fiscal Year 2003 until the present time, broken down by craft hull number. He also provided a background number of CMAV costs.

C. OPERATIONAL DATA

To obtain the operating hours of the craft, a request was first made to the ACU-1 Operations Officer. Originally, an Excel spreadsheet was provided from his office listing the operating hours from each craft. However, after further discussions it was determined that the Operations Summary (OPSUM) reports on file would provide a more detailed account of LCU operations. The OPSUM reports document the operations conducted each week and the hours spent underway locally as reported by the various craftmasters. The authors used the OPSUMs to determine the total number of local operating hours, the breakdown of the type of operations that the craft conducted in a given week, and the number of craft on deployment. These data were consolidated into quarterly figures which allowed the authors to more closely align the data with the financial data. The one key piece of data that was missing from the OPSUMs were the hours spent operating while on deployment.

The authors indentified a separate measure from which to obtain operating hours. These data were gathered from records relevant to the LCU's main propulsion systems, the Diesel engine inspection (DEI) reports. The Navy maintains engine logs as a historical record of engine use and performance for the Navy's maintenance and acquisition community. These reports detail the number of hours in operation and are generally considered within the Navy to have high standards of accuracy. We decided that these records would serve as a strong second check on the operational hours reported on the OPSUMs, and could potentially provide a measurement of the number of operating hours while on deployment. Contact was made with the ACU-1 Diesel Inspector to obtain the required reports.

In addition to establishing the cost vs. operating hour relationship, there was the need to establish the justification for the number of craft ACU-1 has. The major source document for this section was the OPNAVINST 3501.93D "Required Operational Capabilities and Projected Operating Environment for Naval Beach Groups and their Elements" (ROC/POE), obtained from the Operations Officer for NBG-1. The current form is a draft instruction that is in routing for approval, and while it is not an officially approved document at this time, the authors decided to use it as the baseline instruction going forward in anticipation of its acceptance. To supplement the requirements documentation in the ROC/POE an interview was conducted with a member of NBG-1 The staff member provided the authors with a generic Operations Plan requirement for LCUs for our analysis.

D. PERSONAL INTERVIEWS

In addition, the authors conducted interviews with members of the NBG-1 and ACU-1 staff to obtain background information into the operating environment and current challenges in operating the LCUs. Information from these interviews may not have led to direct references but informed the opinions and direction of the authors during the project. The interviewees and the subject areas discussed are as follows:

Position	**Subject**
Commanding Officer NBG-1	Commander's Issues
Commanding Officer ACU-1	Commanders Issue's
Operations Officer ACU-1	Craft Operations
Division Officer ACU-1	Craft Operations/Training
Supply Officer ACU-1	Budget/Spending
Supply Officer (Relieving) ACU-1	Budget/Spending
Training Officer ACU-1	Craft Training
Operations Officer NBG-1	Craft Requirements
Diesel Inspector ACU-1	Diesel Requirements
Port Engineer	Craft Maintenance
NBG-1 Requirements	Craft Requirements
Model Developer ACU-5	Model Theory

Table 1. Interviewees and Subject Matter

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III. DATA ANALYSIS

A. REQUIREMENTS ANALYSIS

1. OPLAN Analysis

Assault Craft Unit ONE is currently assigned a total of 16 LCUs. Four are designated to be forward deployed with the detachment WESTPAC located in Sasebo, Japan. The other 12 craft are located in San Diego, with two permanently retired due to serious maintenance concerns. Plans are currently in place to replace these craft with two LCUs transferred from the East Coast units (Lockwood, 2009).

The current OPLAN requires nine LCUs from San Diego and four LCUs from detachment WESTPAC to be provided in the event of a major operation. The OPLAN details the number required for a single operation in a single theater (Cervantes, 2009). A limitation of the OPLAN number is that it does not reflect the need of any other theater operations that might be conducted simultaneously or services that are provided to other Department of Navy or Department of Defense commands. Another limitation of this number is that it does not take into consideration current operational availability of the craft. Training, maintenance, and other operational requirements will require a larger number of craft to be assigned to ACU-1 for them to maintain nine operational-ready craft.

2. ROC/POE Analysis

A more detailed breakdown of the requirements placed on ACU-1 is contained in the ROC/POE. This instruction is issued by the Chief of Naval Operations through the Expeditionary Warfare Division with input provided by the Beach Groups and associated Teams. The purpose of this instruction is to detail the types of missions that Naval Beach Group units are expected to undertake and the numbers of craft that are required to carry out the expected missions.

The ROC/POE directly addresses the day to day requirements for craft of ACU-1. As shown in Table 2, the breakdown of craft calls for 7 craft to be available from San Diego for deployment at any time. This is based on ACU-1 being able to support one LHD (2 craft) deployment and one LHA (3-5 craft) deployment simultaneously (U.S. Navy, 2009). As the current *Tarawa* class of LHAs are phased out of the fleet there is a certain amount of flexibility in this breakdown. Only one LHA remains in the Pacific Area of Responsibility compared to three LHDs. Based on interviews with the ACU-1 Commanding Officer, most recent LHA deployments have been provided with the minimum of three LCUs per ARG, which if numbers hold, would allow ACU-1 to support four ARGs between the San Diego, and Sasebo based units (Lockwood, 2009). The authors attempted to validate the number of LCUs requested by each MEU, however no historical record of MEU requests was maintained.

In addition to their own training requirements, ACU-1 must also support the training requirements of the units with which it operates. The team is called upon to support the training of all the well deck equipped amphibious ships as well as Beach Master Units, and Marine units between deployment cycles plus various other fleet requirements when able. The ROC/POE requires three craft to be available at all times to support these training requirements.

The final two craft are available for maintenance. The Joint Fleet Maintenance Manual (JFMM) requires that a craft undergo a Depot Maintenance period every four to five years (U.S. Navy, 2008). Currently ACU-1 is funding dry-docking availabilities at the rate of two per year, each lasting roughly six months. This drydock schedule accounts for one of the two craft designated for a maintenance status. Furthermore, this schedule is sufficient to maintain ten operational West Coast LCUs. However, once the two out of service craft are replaced there will need to be two additional dry dock periods scheduled in the five-year rotation to meet their obligations under the JFMM.

The second craft dedicated to maintenance in the ROC/POE would be used to account for emergent repairs and Consolidated Maintenance Availabilities (CMAV). CMAVs are planned maintenance periods usually lasting two to three weeks when a craft is made available for more involved repairs and modifications that ACU-1 cannot or should not attempt to schedule during the normal operational schedule. The CMAV is coordinated with various repair activities and outside contractors to maximize the amount of work completed during these out of service times and are essential to maintaining the overall material condition of the craft.

3. A_o Analysis

By following the ROC/POE force structure, a structural A_o can be derived. An A_o figure of 83.3 percent is required for the craft based in San Diego to support the ROC/POE requirements. For the craft based in Sasebo an A_o figure of 75 percent is required to support the ROC/POE requirements. Table 2 consolidates both of these calculations. One caveat that the current OPLAN numbers require four craft to be ready for deployment which would require a 100 percent craft availability at all times in order to meet that requirements. That number is not practical at the current craft level.

	San Diego	Sasebo
O Plan	9	4
ROC/POE	12	4
Deployed	7	3
Local	3	0
Maintenance	2	1
Required A_o	83.3%	75%
4-5 year DPMA cycle as required by JFMM		

Table 2. Requirements Document Breakdown (After: U.S. Navy, 2009)

Throughout the course of the authors' research, it was possible to perform a validation of this A_o calculation. Table 3 shows the average number of craft in a given status over the three years of 2006 through 2008. From this, an A_o calculation of 81.25 percent was determined. The authors were unable to calculate an actual A_o figure because craft status is currently tracked on a weekly vice daily basis.

Average values for 2006, 2007 & 2008	
(values shown are in #'s of craft)	
In port	6.46
DEI	0.31
CMAV	0.75
DPMA	1.56
Deploy	4.92
Total	14.00
Available = In port + Deploy	11.38
A_o = Available / Total	81%

Table 3. A_o Calculation Validation (After: ACU-1, 2006) (After: ACU-1, 2007) (After: ACU-1,2008)

B. INITIAL DATA ANALYSIS

The authors began their analysis by first examining the BOR reports, focusing on SR expenditures to simplify the data set. As previously stated, the authors concentrated their analysis on the SR fund code, since these expenditures best represent funds spent on maintenance-related items. The authors reviewed SB expenditures, but these expenditures represented less than 2 percent, on average, of the total expenditures between 2006 and 2008. In the authors' experience, other fund codes may contain some maintenance-related expenditures. Due to time and scope limitations, the authors were unable to separate these maintenance-related expenditures within these other fund codes. For the aforementioned reasons, the authors focused on SR expenditures, and excluded all other fund code analysis from this project.

Analysis of the initial data that was received indicated little statistical relationship between the maintenance dollars spent (SR) and the operating hours of the craft, as shown in Figure 2. The linear regression model between hours and dollars produced a R^2 of 0.031, meaning that 97 percent of the variation was not explained with the data sets. Given the lack of any statistical significance in these data, additional information was obtained to further develop a model that could better represent a relationship between hours and expenditures. The new data include, the in port operating hours of LCUs in San Diego, the number of craft in port, on deployment or in a maintenance period in San Diego or Sasebo. The Diesel inspector provided figures for the total Diesel engine run hours for the craft, further evidence of the actual usage of the craft. The port engineer and supply officer provided DPMA cost amounts, CMAV estimates, and total OPTAR figures The financial data were corrected for inflation using the inflation calculator available at the Naval Center for Cost Analysis website (U.S. Navy, 2009). The data included information from 2003 through 2008, but were most complete in the years 2006 through 2008. The limited number of years of complete data became a limiting factor in the scope of this project.

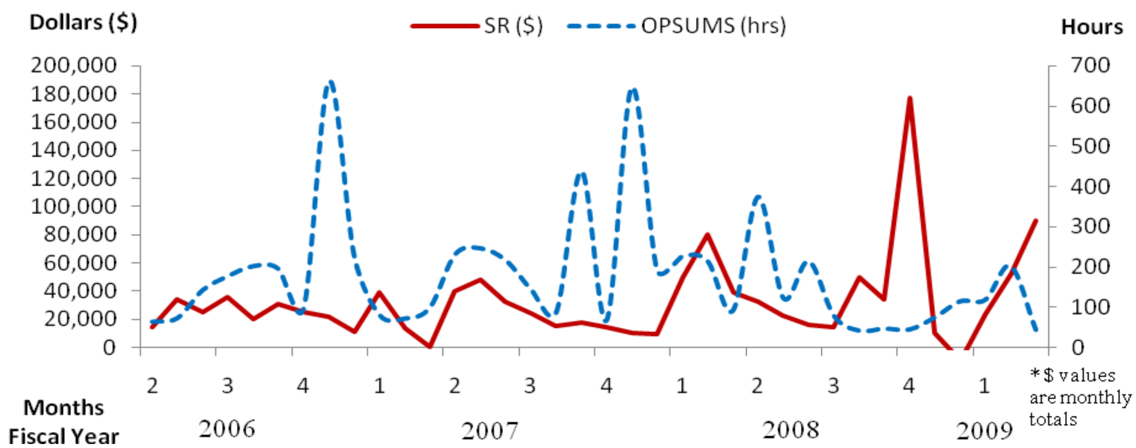

Figure 2. Local Operating Hours vs. SR Expenditures (Appendix D, Table 12)

The first information obtained from the new data was the breakdown of the total hours spent on various tasks by LCUs in San Diego, by week. When totaled, there was a ten percent difference between the initial reported hours and the new data. Both were supposed to represent the total in port operating hours. The new data were obtained from the weekly source documents; therefore the decision was made to perform further analysis using the new data. However, the initial simple linear regression model failed to provide appreciable improvements. The authors then began to analyze the information, looking at such things as the number of craft in port or on deployment, as well as taking into consideration the total Diesel engine operating hours as an estimate of deployed operating hours.

An analysis of the data representing the number of craft and their current usage is show in Figure 3. The graph is a representation of the ten craft assigned to San Diego, and their monthly utilization, on a percentage basis. Noticeable in this graph is that in the first five quarters a larger percentage of craft, roughly a 60-40 split, were used for local operations vice deployed. The next five quarters have more craft on deployment, with a roughly 30-70 split.

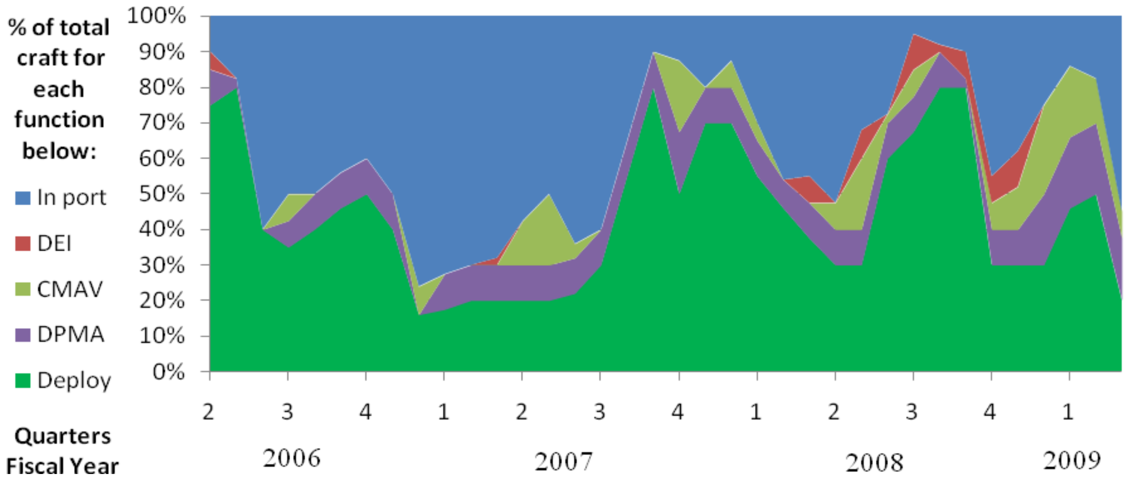

Figure 3. San Diego LCUs by Function (Appendix D, Table 25)

C. LOCAL OPERATING HOUR ANALYSIS

With an expectation that the hours of operation drove maintenance dollars, the authors decided to compare the OPSUM local hours to the SR maintenance dollars. As shown in Figure 4 with a fit (i.e. R^2) of 0.193, there is little direct relationship between SR maintenance dollars and local operating hours. The level of the relationship could be explained because operations and repairs do not often occur simultaneously. In the authors' experience, it is far more common that higher operating tempos results in repairs occurring weeks or months after the fact. As a result, Figure 5 shows a shifting of SR expenditures to the left by one quarter, to account for this lag between operations and maintenance.

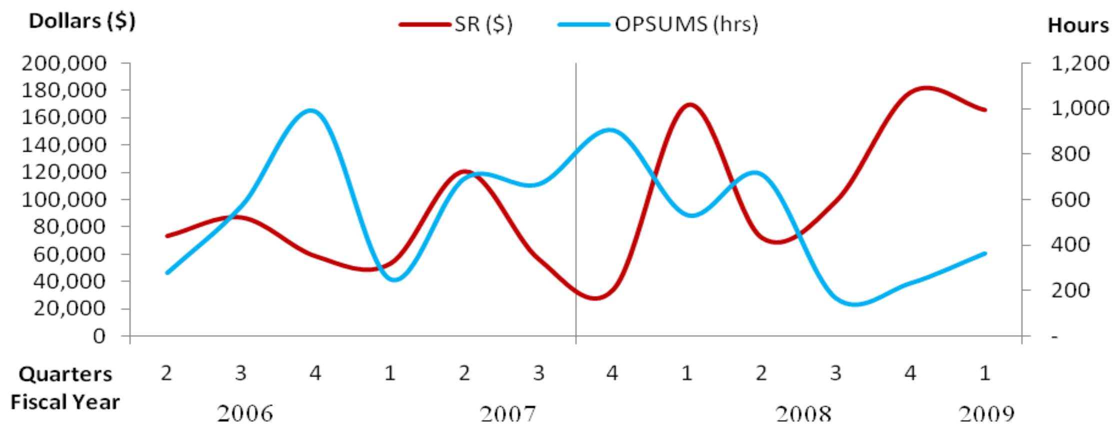

Figure 4. Local Operating Hours vs. SR, by FY Quarters (Appendix D, Table 13)

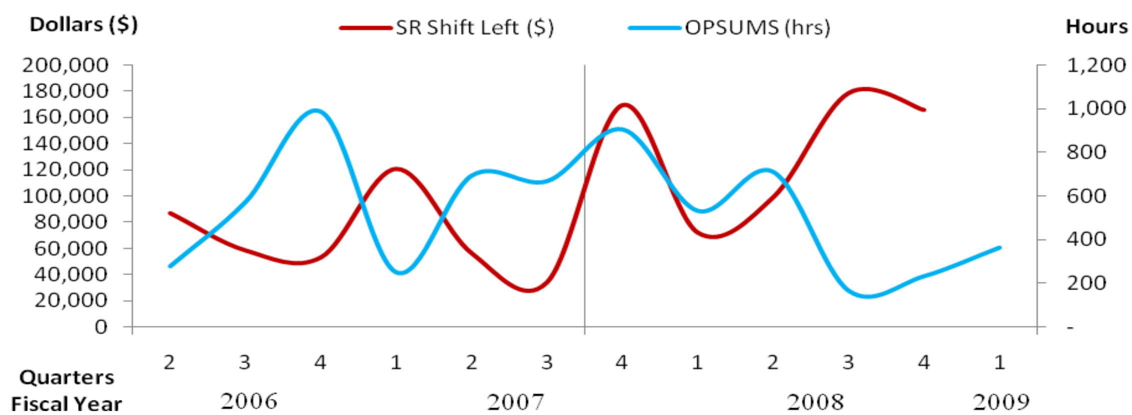

Figure 5. Local Operating Hours vs. Left-Shifted SR, by FY Quarters (Appendix D, Table 14)

However, shifting SR expenditures to the left did not result in a higher fit by itself (R^2 of 0.194). Noticeable is an inverse relationship in the period of higher local operating hours, as shown in Figure 6. Figure 6 shows only the first five quarters depicted in Figure 5. Performing a linear regression on this specified period resulted in the Local Operating Hours Model (LOHM), with a fit of 0.698. This stronger association lends support to the assumption that there is some relationship between operating hours and SR expenditures.

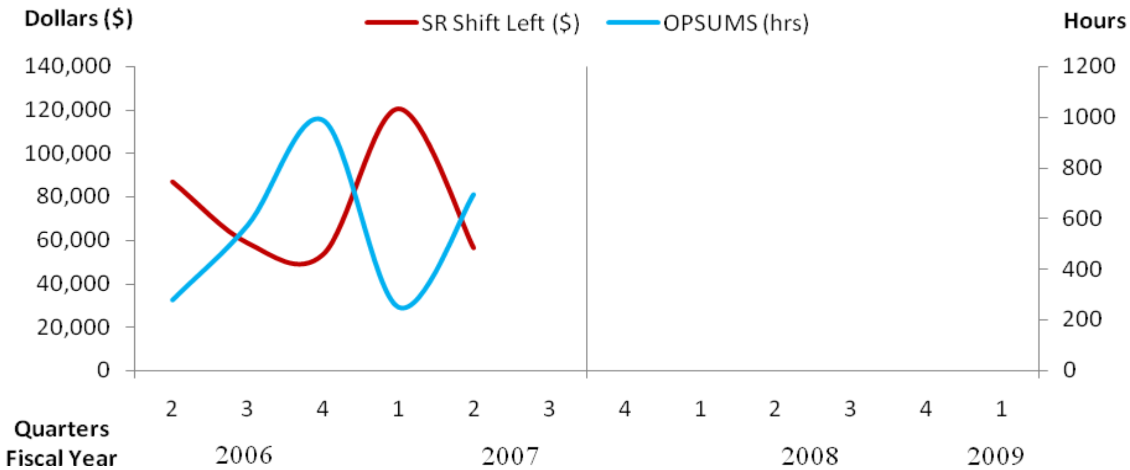

Figure 6. Local Operating Hours vs. Left-Shifted SR, by FY Quarters, for the First Five Quarters of the Total Data Set (Appendix D, Table 15)

D. DEPLOYED CRAFT ANALYSIS

Next, the authors examined the relationship between deployment operations and SR expenditures. Deployed operating hours are defined as those hours spent while the craft is attached to an ARG. However, these hours are not currently tracked, and therefore were not available for analysis. The OPSUMS do provide a historical record of the number of craft that were deployed, and while this measure may not perfectly map to the hours operated underway, it does provide an estimate where data were otherwise not available.

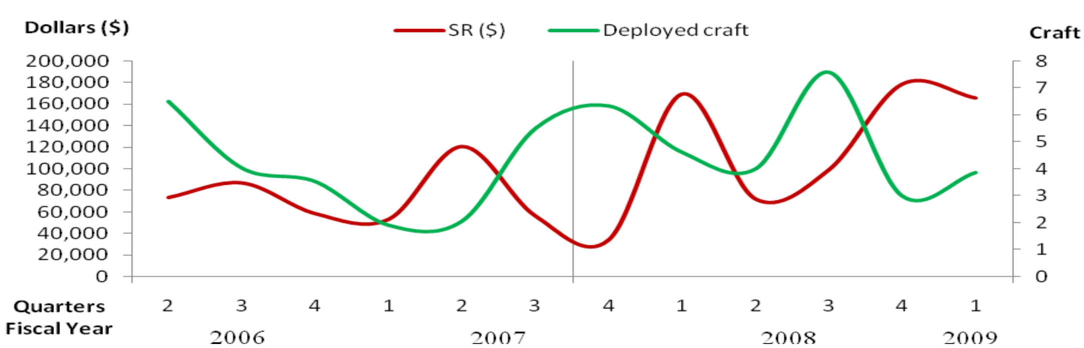

Figure 7. Deployed Craft vs. SR, by FY Quarters (Appendix D, Table 16)

Figure 7 is a representation of the number of craft deployed versus SR expenditures. The authors performed a linear regression model and found a fit of 0.063. As with local operating hours, it is likely that maintenance dollars would be spent in the quarter following operations. In the authors' experience, this trend is far more likely in the case of the deployed craft, where most maintenance occurs after a deployment ends. Figure 8 depicts SR expenditure data again shifted to the left to account for this assumption. While the fit does improve to 0.094, what is observed in the data is the five quarter period noted in Figure 9, representing a period of high deployment. Performing a linear regression on this specific period resulted in the Deployed Craft Model (DCM), with a fit of 0.470.

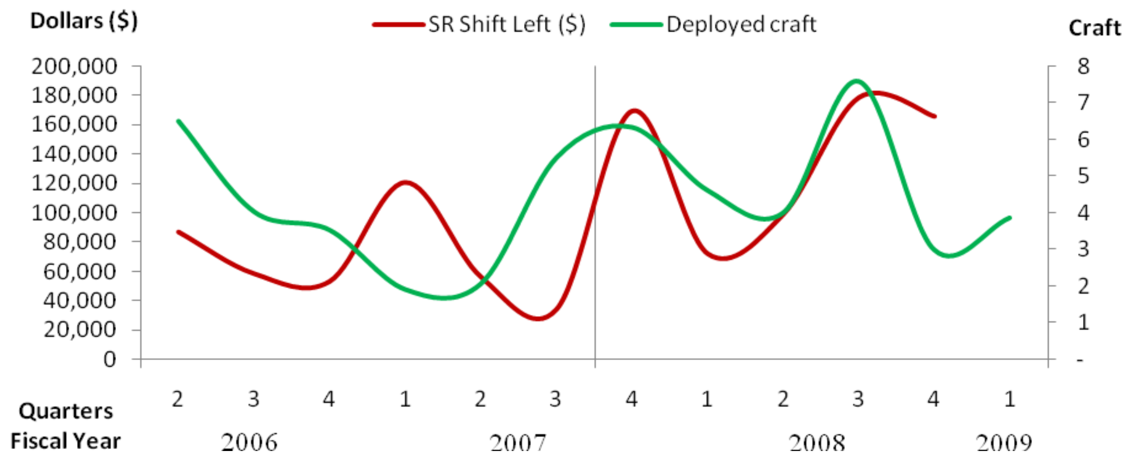

Figure 8. Deployed Craft vs. Left-Shifted SR, by FY Quarters (Appendix D, Table 17)

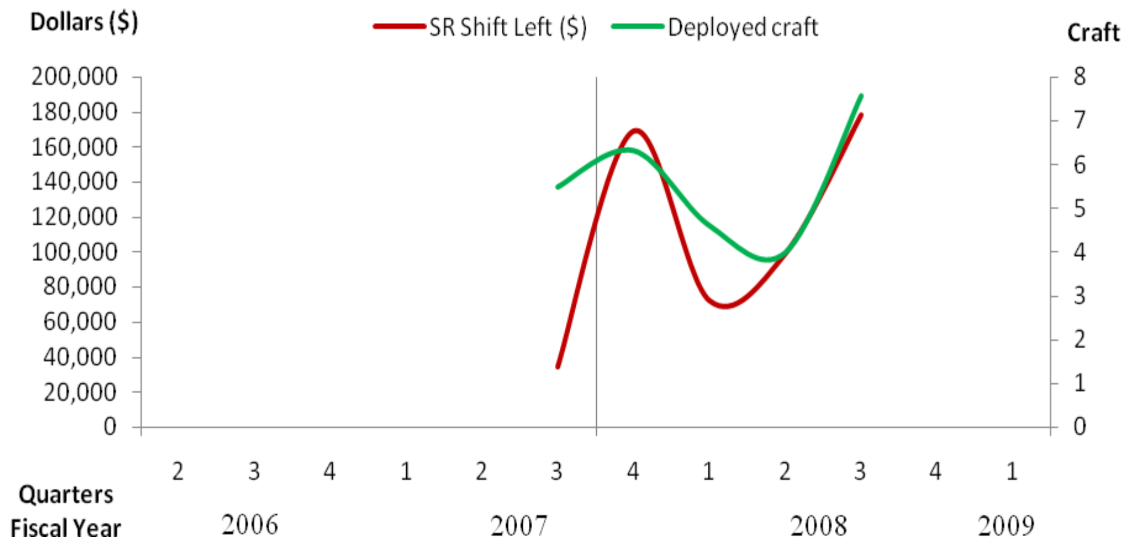

Figure 9. Deployed Craft vs. Left-shifted SR, by FY Quarters, for the Second Five Quarter Period of the Total Data Set (Appendix D, Table 18)

E. COMBINED SR EXPENDITURE PROJECTION DETERMINATION

Upon completion of the Local Operating Hours Model (LOHM) and the Deployed Craft Model (DCM), the authors now had two models which explained some of the relationship between future quarterly SR expenditures and current quarter craft operations. Understanding that each model contributes to the explanation of total SR expenditures differently, the authors devised a way to integrate the models into a Combined SR Expenditure Projection (CSREP). This section describes this process.

The first step in creating the CSREP was to establish common units between the different models. The DCM does not have a direct hour translation, but does provide a SR dollar amount. Since the LOHM also provides an SR dollar amount, this provides the common units for combining the models. The LOHM and DCM are weighted by the proportion of the San Diego craft that were either in port or deployed. Figure 10 shows the individual models arrayed against actual SR expenditure data. The new projection, shown in Figure 11, has a correlation to the actual SR expenditures of 0.570 out of a possible value of -1 to +1.

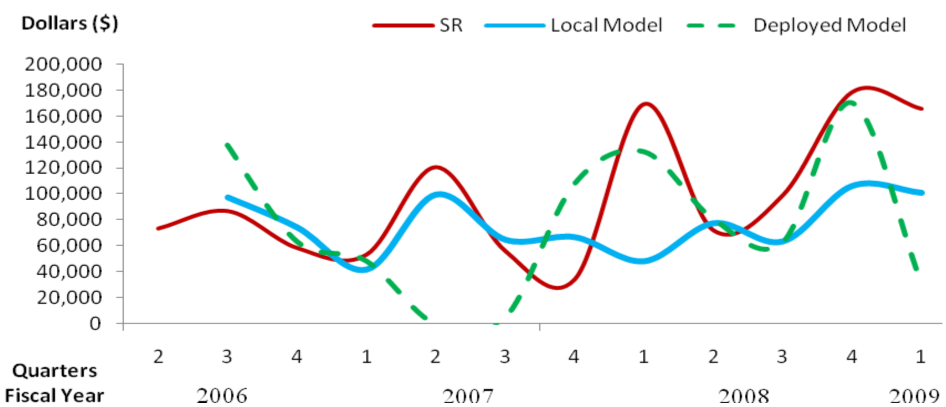

Figure 10. LOHM, DCM vs. Actual SR Expenditure Model (Appendix D, Table 19)

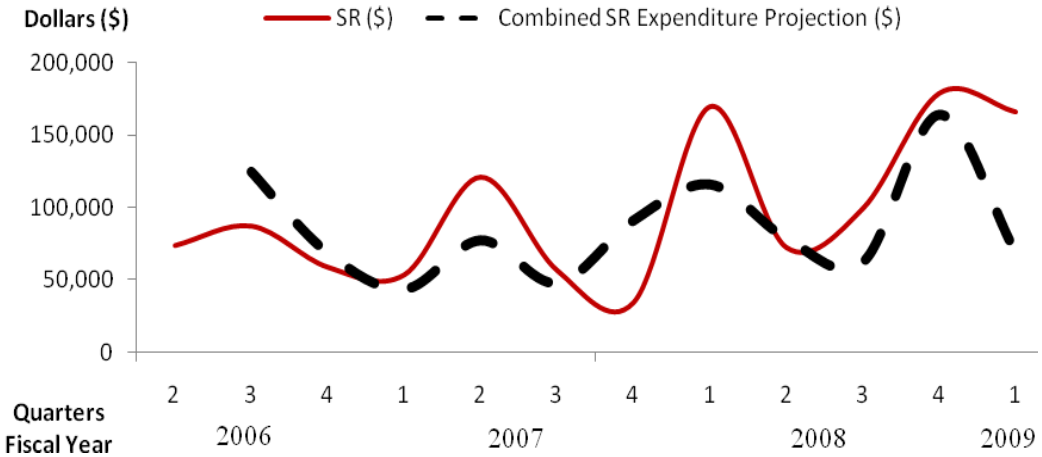

Figure 11. CSREP vs. Actual SR Expenditure Data (Appendix D, Table 19)

F. CONVERTING THE COMBINED SR EXPENDITURE PROJECTION TO A TOTAL QUARTERLY EXPENDITURE ESTIMATE

1. Determining Conversion Factors

In order to transform the CSREP to a Total Quarterly Expenditure Estimate (TQEE), two conversion factors needed to be developed. The first conversion factor accounts for the craft stationed in Sasebo. The OPSUM data did not provide local or deployed operating hours for the Sasebo-based craft. The Diesel Engine Inspection (DEI) reports however, did include the Diesel engine hours of all craft, including those stationed in Sasebo. These reports are compiled roughly every 18 months. Since the reports cover different periods of time and since DEIs are staggered, an average was taken of the DEI data for both San Diego and Sasebo for comparison. The average of the Diesel engine hours per month for the San Diego based craft is 28.0 hours per craft, versus an average of 19.8 hours per craft for the Sasebo-based craft. The Sasebo-based craft account for, on average, 41.5 percent of the total Diesel engine hours over the DEI reporting periods, and the San Diego-based craft account for 58.5 percent. To allow the authors to account for the Sasebo-based craft in the CSREP, it was necessary to divide the CSREP dollar figure by the percentage of the total Diesel engine hours that the San Diego-based craft represents. This is represented by K3 in Figure 12, which in this case has a value of 0.585.

Having converted the CSREP to include Sasebo-based craft, the final step is to convert SR to total expenditures. The difference between SR expenditures and total OPTAR expenditures is the remaining fund codes. The conversion factor is based in part on research obtained from a thesis pertaining to surface ship OPTAR accounts (Kuker and Hanson, 1988) and based on the authors' experience. The conversion factor is the ratio between SR expenditures and total expenditures. The ratio that the authors used is 0.35, which corresponds to factor K4 found in the model in Figure 12. The data supporting the K4 conversion factor can be found in Appendix E, Table 31.

2. The Total Quarterly Expenditure Estimate

To calculate the TQEE, multiply the CSREP by the conversion factor K3, and divide by the conversion factor K4, as shown in Figure 12. This TQEE amount calculated represents an estimate of quarterly OPTAR expenditures based upon the number of San Diego craft deployed, number of San Diego craft in port, and the actual operating hours for San Diego craft. These variables are all taken from the previous quarter's data, to account for the time lag previously discussed between operations and maintenance expenditures.

3. The Total Expenditure Estimate

To arrive at a final Total Expenditure Estimate (TEE), it is necessary to calculate the TQEE for each quarter individually, and sum the four TQEEs. After calculating TEE, the authors correlated total actual expenditures to TEE, and found a correlation of 0.597. Figure 13 shows a graphical representation of total actual expenditures and TEE relationship. The final model, including the linear regression produced intercepts, slopes, and appropriate conversion factors already described, is included in Appendix D, Equation 1.3.

To estimate the annual budget for ACU-1, it is necessary to add CMAV and DPMA expenses to the annual version of TEE. However, not having the spending pattern of CMAV and DPMA related expenses, this final step was not included. For ACU-1 to arrive at the total yearly estimate, it would be necessary to convert the TEE to yearly amount, and add the CMAV/DPMA values.

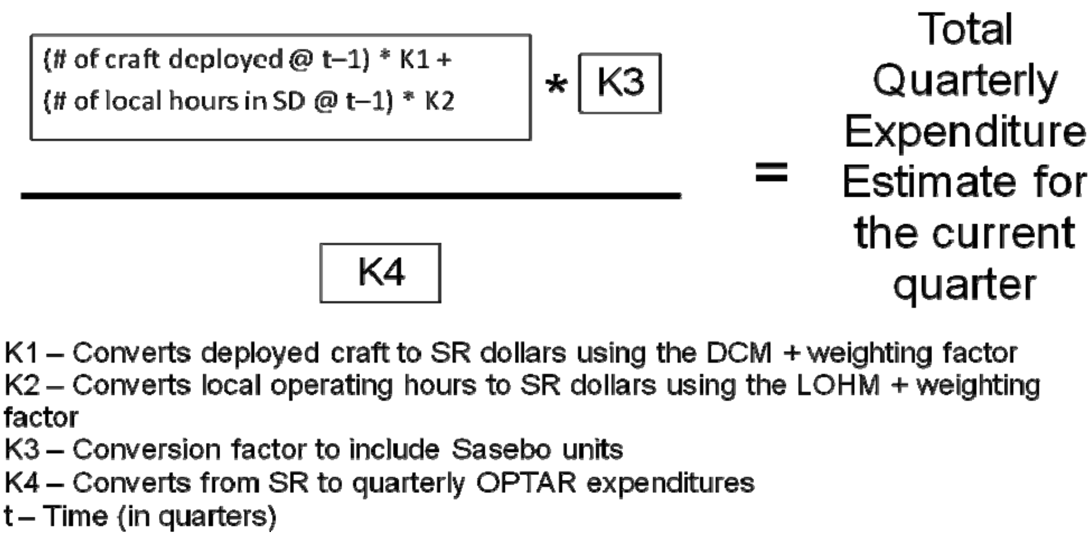

Figure 12. Simplified Total Quarterly Expenditure Estimate Equation (Appendix D, Equation 1.3)

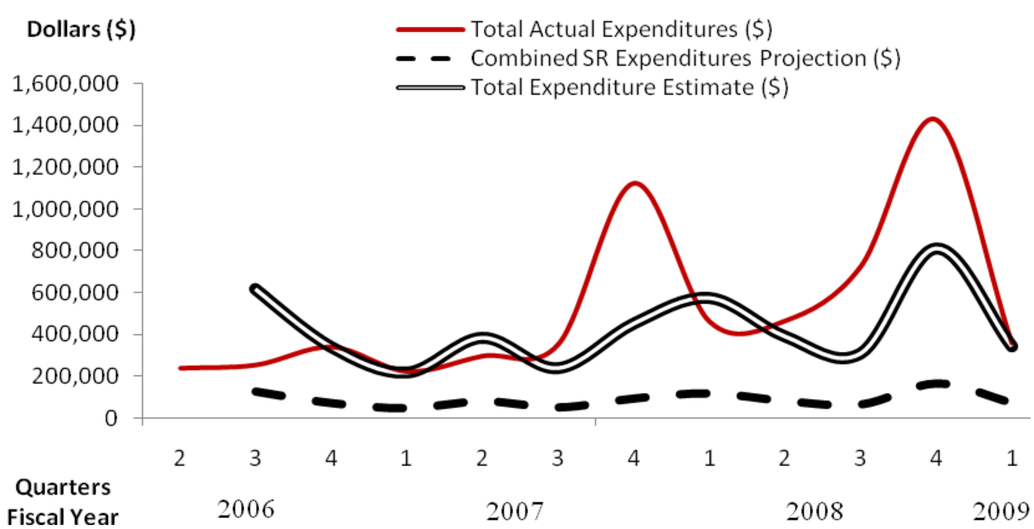

Figure 13. Total Expenditure Estimate vs. Total Actual Expenditures (Appendix D, Table 20)

4. Accounting for the Differences Between the Model and Total Expenditures

While the model does maintain a correlation of 0.597, there are surges in spending that the model is not able to explain. Some of the differences may be the result of errors, which will be covered shortly, but there may be explanations provided by other sources as well. One such source is the ACU-1 Financial Balance sheet and transfers in and out of the Total OPTAR account. As shown in Table 4, FY 2007 had a fairly stable funding pattern over the first three quarters. The fourth quarter grant increased more than $1.2 million. We were not able to determine the reason the grant increased by such a large amount. In turn, this affected the amount of money available for other expenditures.

FY 2007	Grant ($)	COW Augment ($)	Transfers ($)	Expenditure ($)	Balance ($)
1st quarter	220,000			210,481	9,519
2nd quarter	300,000			287,078	22,441
3rd quarter	378,000	1,101,000	1,115,000	341,678	44,763
4th quarter	1,602,000		565,000	1,081,763	-
Totals	2,500,000	1,101,000	1,680,000	1,921,000	-

Table 4. FY 2007 OPTAR Balance Sheet (After: Woodward, 2009)

While the FY 2007 grants could be explained, in part, due to transfers, the FY 2008 transfers do not fully explain the elevated totals noted. The grants in FY 2008, as shown in Table 5, exceed nearly all past grants in FY 2007, and in most cases, exceeds the total of the first three quarters of FY 2007 combined. We were unable to determine any specific reason that the grants increased by such a large amount. We were able to determine that the majority of all funding received went to cover DMPA/CMAV related expenses.

FY 2008	Grant ($)	COW Augment ($)	Transfers ($)	Expenditure ($)	Balance ($)
1st quarter	1,350,000		901,000	445,226	3,774
2nd quarter	1,800,000		1,311,000	459,706	33,068
3rd quarter	1,220,000		470,000	715,609	67,459
4th quarter	1,823,500	3,961,000	4,372,165	1,407,137	72,657
Totals	6,193,500	3,961,000	7,054,165	3,027,678	72,657

Table 5. FY 2008 OPTAR Balance Sheet (After: Woodward, 2009)

G. PROBLEMS NOTED IN THE DATA SETS

1. Financial Data

There were no significant deficiencies noted in the financial data, but the lack of specificity or traceability of spending to separate hull numbers is an issue. While it is possible to show spending and overall trends, the inability to trace funds obligated to hours operated and readiness achieved for one craft over another is a problem. For this model to be fully effective, the ability to track all of this information, dollars, hours and readiness per craft is essential. The alternative is a model that may be descriptive of overall trends, but may not show the cause and effect for each craft.

When requested, ACU-1's Port Engineer was able to provide specific data regarding the DPMAs, the data surrounding the CMAVs were less clear. In the case where the model is attempting to describe all aspects of spending, including availabilities, and show the effect on readiness of the craft, it is important that the money spent on CMAV be tracked. Relating these data, the spent funds, to the change in readiness may provide a more robust model, or at least provide an indication of the effectiveness of the money spent on CMAV in terms of the readiness achieved.

2. Craft Operation Time

There were a few problems noted with the data concerning the operating hours of the craft. The problems with the data can be broken down into two areas: 1.) problems with the actual data itself and 2.) the absence of better data. The OPSUM data had a variety of problems. There were five occasions in 2008 where the OPSUM weekly reports reported that craft had completed tasks, but no hours were reported. Sometimes the list of tasks were quite extensive, and consistent with tasks completed in earlier weeks, but there was no annotation of hours spent. In these cases, a reasonable consistent assumption, based on an analysis of data in the surrounding months was made for these missing hours.

Accuracy was also found to be an issue. Operational Hours reported were all rounded to the nearest full hour. This rounding over time could result in a deviation from actual hours incurred. Another problem with accuracy is one of miscalculation. There were instances that the weekly total listed on the OPSUM did not correlate to the sum of the individual operations listed. The choice was made by the authors to use the sum of the individual items, rather than the total listed. Another accuracy problem was found with one of the completed tasks. In this case, two craft were said to have completed in excess of 600 hours of work in one week. Given that there are only 168 hours in a week, the two craft could have only completed, at most, 336 hours. The decision, in this case, was to choose the 336, since the other number seemed unrealistic.

While these data were not exact or accurate, the time periods the models were built in was on the scale of quarters, not weeks or months. As a result, these inaccuracies should have been minimized by averaging, but the very action of averaging can hide trends and other facts. That the TEE only accounts for 60 percent of the variability of the actual total expenditures is likely due in part to these problems.

Finally, deployed operating hours are not tracked. While attempts were made to estimate these hours in our models, having the actual data would provide a better indication of hours, and therefore remove any inaccuracies from the estimation. These hours were not noted on the OPSUMS, but could be calculated from either the deck logs of the craft, or the Diesel engine logs. In the future, the lack of data could be mitigated by providing this information in the OPSUMS or, at a minimum, providing the information to the ACU by the Craftmasters for any hours operated while a craft was on deployment. Either option would capture this information and would aid in future development of a predictive model.

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IV. RECOMMENDATIONS AND CONCLUSIONS

A. RECOMMENDATIONS

1. Craft Status Tracking

Recommendation: Track craft status on a daily basis during operations and consolidate into a single database.

The principle limitation to the authors' ability to derive a model that fully accounted for ACU-1 expenditures was the lack of accurate data. To improve the quality of data, the authors recommend that ACU-1 begin long term tracking of LCU status in terms of full mission capable, partial mission capable, and non-mission capable on a daily basis. Currently, craft status is reported weekly via the OPSUMs with no follow on analysis. The authors argue the status should be reported daily to ensure the accounting of all craft downtime. The current format leaves the possibility that if a craft is not functioning and is fixed during the reporting period and is not recorded; causing the calculated A_o to be overstated. The daily data can then be analyzed to provide ACU-1 with a more accurate metric to evaluate the material condition of their craft and the effectiveness of their maintenance efforts.

2. Tracking Individual Craft Operating Hours

Recommendation: Track operational hours by craft to include deployed units.

The authors further recommend that ACU-1 track operating hours while on deployment and that all operational hours be reported by individual craft. The lack of detailed deployment operating hours caused the authors to rely on an estimate of deployed operating hours. Further all operational hours, whether local of deployed, should be reported for the individual craft. Currently craft are reported as a group, if two craft participate in an exercise the underway hours reported will reflect the exercise time and not necessarily the time each craft spent underway.

3. Tracking MEU LCU Requests

Recommendation: ACU-1 should keep a record of LCU requests by each deploying MEU to serve as a historic reference of requirements.

The authors recommend ACU-1 track actual LCU requests made by the MEU planners prior to deployment. ACU-1's Commanding Officer made a comment that ACU-1 over the past few years has regularly been asked to provide more LCU's than they were able to (Lockwood, 2009). The authors attempted to verify this claim but were unable to, due to the informal nature of the request system. Currently, the entire process is via E-mail sent through the NBG-1 operations officer with no official historical record kept. The authors feel this is an important indicator of MEU requirements and should be kept by ACU-1 as an important record of actual demand for their craft.

By tracking the above information in the manner recommended it will be possible for ACU-1 to accurately document their overall requirements for craft and underway hours and calculate a very accurate A_o. This information when applied would greatly increase the ability of the model to accurately represent the true requirements of ACU-1.

4. OPSUM Data

Recommendation: Increase emphasis on message accuracy.

While analyzing the data that was reported via the OPSUM data numerous errors were noted by the authors. It was understood prior to this project that great accuracy in the data was not necessary. However, to use the data for predicting resource requirements, the data need to be more closely examined before being submitted. Prior to submittal ACU-1 needs to verify that accurate data are on the message.

B. CONCLUSIONS

This report is the first step in an ongoing process to develop a requirements-based budget model for ACU-1. One goal of this project was to create a basic model and document the methodology so that ACU-1 could continue to improve upon the model after the completion of the project. A second goal of this project was to document the actual requirements that feed into the basic model so that future spending can be based upon a desired level of operational availability.

In this project, the authors documented the number of LCUs required to support ACU-1's operational commitments and the structural A_o of LCUs. The actual A_o of the craft was not able to be determined due to the problems with the data as described in Chapter 3 section A. Recommendations to correct these discrepancies are included in section A of this chapter and in Appendix A. A relationship between local operating hours, the number of craft on deployment, and funds obligated in the SR fund code was found. Based upon this relationship, the authors developed an estimator that is able to explain 60 percent of past expenditure variations.

C. AREAS REQUIRING FURTHER STUDY

In the course of conducting our research, the authors identified several areas that, if studied further, have the potential to better develop the financial model and further explain the requirements that drive the model.

First, an analysis needs to be conducted of the spending and maintenance requirements that determine the total cost of DPMAs and CMAVs. A review of the requirements was not completed due to a lack of engineering knowledge on the part of the authors. Also, due to scope limitations, the authors did not perform an analysis of the items that have been included in past DPMAs or CMAVs. The assumption was made that Commanding Officer, chief engineer, and port engineer made their decisions on the amount of work to perform during each DPMA and CMAV based upon work that needed to be completed and the amount of available funding.

Second, an analysis should be conducted of spending under the SC fund code. After discussions with the ACU-1 staff, the authors believe that some maintenance costs are incurred under the SC fund code. Due to the broad nature of spending that is included within the SC fund code and the limitations of the financial tracking system, it is not possible to separate maintenance spending from the rest of the category. The authors believe that the amount of maintenance spending completed under SC was not relatively large. A more detailed analysis could allow this to be added into the existing calculations.

Once ACU-1 has a more accurate record of craft status for a period of 18 to 24 months, it will be possible to more closely tie operational availability to actual costs incurred. For this project, we were only able to use the nominal A_o figure, but a more accurate A_o figure will allow for better decisions to be made in funding to support a required level of readiness.

Finally, it is possible to use the same process that the authors described to perform similar analysis on the other units of NBG-1. All of the units are funded by the same 1C6C budget category for which the authors have only touched a small portion of the total budget. Each subordinate command of NGB-1 should perform a similar study to aid in the preparation of the 1C6C budget.

APPENDIX A. TRACKING DOCUMENT

Craft status is currently tracked weekly by ACU-1 through the OPSUMs. While this method provides a history of craft status, the information contained was insufficient for this project. The status was tracked weekly vice daily. No definition was provided as to the different type of craft status. There was not a breakdown of the craft's ability to meet one type of mission requirement over another. An example of this would be craft that was unavailable to be deployed due to mechanical failures, but could still meet local training missions, thereby contributing to the overall readiness of ACU-1. This appendix includes various tables that could be utilized by ACU-1 as a means of tracking these statuses.

Different factors were used for the basis of this spreadsheet; specifically, providing quantifiable descriptors of a crafts' status. The assumptions for the tables are shown here:

1. All the missions that a craft (LCU) can be assigned to can be grouped into the following set of three:
    a. Training missions
        i. This includes qualification / proficiency for operators
        ii. Workups for a upcoming deployment
    b. Service requests (SERVALLs)
        i. Weapon movements
        ii. Training for other commands
        iii. Other miscellaneous assignments
    c. Deployments
2. There is a maximum number of assigned craft to ACU – 1 of sixteen.
3. The number of craft available for the day is assumed only to be those actually available for that day, not ones that could be available within a day or two. For example, if a craft could be made available for a training

task that is coming up in two days, but is not available today, it would still be counted as down for training today, even though it could be rapidly restored, if necessary.

The first table is presented with the simplest tracking mechanism for the craft. The minimum amount of information is tracked, showing only the ability for a craft to complete one of the three missions shown. The intent of this table is for the individual Craftmasters assigned to the LCUs to make the daily determination of the crafts status, and communicate this information to the spreadsheet either directly, or through an appropriately designated point of contact within the ACU-1 staff. An example of this sheet is shown below.

	Training	Servalls	ESG
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

Table 6. Simplified Tracking Document

The next step in adding more detail to the tracking system involves adding sections involving the status of specific systems onboard each craft. For the purposes of this appendix, the basic system requirements have been broken down into the following list. It is assumed that combinations of up and down status for various components of this list would allow for a more detailed reporting of the craft status to the ACU staff, and provide a documented history of systems that are “down” most frequently. This history could be used to determine possible periodicity of system problems, and provide day-to-day status of each craft. The list of applicable systems follows here, and an example of this type of table is included afterwards:

1. Watertight integrity
    a. This could also be defined as the ability for the ship to remain afloat within the capacity of its drain pumps.
2. Craft navigability
    a. Defined as the ability of the craft to be driven from shore to the ship.
    b. An example of this would be functionality of the rudder.
3. Power production capacity
    a. The ability for the craft to run its diesel to get the craft underway.
4. Navigation equipment
    a. The equipment necessary to navigate the craft.
    b. Could include such equipment as:
        i. Radar
        ii. GPS
        iii. Running lights, and other Nav-aids
    c. While the first three requirements are mostly essential for underway operations, this requirement could be softened for some missions, e.g. it may not be necessary for a craft to have GPS or Radar, since it could follow other craft from the ship to the beach and return, without a degradation in mission capability.
5. Ability to deploy men and material via the Ramp
6. Ability for the craft to mate with and disengage from an LHD

	Training	Servall	ESG	Watertight	Navigable (Rudder)	Diesel	Nav equip	Ramp (up/down)	EESG hookup
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									

Table 7. Intermediate Table

The next step in adding more detail to the tracking system involves adding a system to evaluate each tracked component and providing quantifiable status or readiness of each craft and of the squadron overall. This would involve essentially the same table above, while making some of the assumptions, provided below, regarding the systems necessary for each craft to complete the various types of missions. Also, using the descriptors provided for each mission, it could be possible for Excel to provide a simple numeric result of craft / ACU readiness each day, based on the requirements listed. An example of a sheet with the appropriate filled in data and result for a typical day is shown in Table 8.

1. Servalls
    a. Watertight
    b. Navigable
    c. Diesel
    d. Nav equip
    e. Servalls are generally service requests for the movement of men or material or other similar requests that are local in nature. It may likely not be necessary that a craft link up with an LHD to

complete these or land on a beach, thus a craft could be mission-ready for a Servall, but not for the next category of Training.

2. Training
    a. Watertight
    b. Navigable
    c. Diesel
    d. Nav Equip
    e. Ramps (opt)
    f. ESG hookup (opt)
    g. Training status can be more ambiguous, since gaining driving proficiency for a Craftmaster may not require the ability to use the ramp, but completing workups for deployment would.
3. ESG or Deployment operations
    a. Would require all systems to be operational
    b. Implies that a craft be fully operational and able to perform any mission presented to it within known requirements.

Additional assumptions for the table:

1. The availability is only determined by those craft not currently in CMAV or DPMA. The craft in these availabilities do not count against the ACU for readiness. However, this lower readiness number (including the craft in the availabilities) is provided for data purposes.
2. For training purposes:
    a. If a craft can meet the basic requirements of the Servall, but nothing more, it is considered to be at 50 percent.
    b. If a craft can also either work the Ramp or operate with an ESG, 75 percent
    c. If a craft can perform all functions, 100 percent
3. While the craft is in a maintenance period, it is considered down across the board, regardless of whether or not a particular system is functional on the craft in the drydock. The condition of the craft would be tracked under the availability

reports, and is considered 100 percent down for purposes of this table, and its calculations.

4. The total number of craft in the ACU is 16, as indicated in the upper – left corner. This number can be changed, but must be updated for the overall table to function correctly.
5. Any craft that is in an availability is shaded out dependent upon the entry of a one in the DPMA / CMAV column of the appropriate craft.

16	Servall	Training	ESG	Water - tight	Navigable (Rudder)	Diesel	Nav equip	Ramp (up/down)	ESG hookup	DPMA / CMAV	Notes
1602	100%	50%	0%	1	1	1	1	0	0		
1610	100%	100%	100%	1	1	1	1	1	1		
1611	100%	100%	100%	1	1	1	1	1	1		
1615	100%	75%	0%	1	1	1	1	1	0		
1624	100%	50%	0%	1	1	1	1	0	0		
1628	0%	0%	0%	0	0	0	0	0	0	1	DPMA
1630	100%	100%	100%	1	1	1	1	1	1		
1640	100%	75%	0%	1	1	1	1	0	1		
1642	0%	0%	0%	1	1	0	1	1	1		
1647	0%	0%	0%	0	0	0	0	0	0	1	CMAV
1652	100%	75%	0%	1	1	1	1	0	1		
1663	100%	75%	0%	1	1	1	1	1	0		
1667	0%	0%	0%	1	0	1	1	0	0		
1671	0%	0%	0%	0	0	0	0	0	0	1	DPMA
1679	100%	75%	0%	1	1	1	1	1	0		
1681	100%	75%	0%	1	1	1	1	1	0		
										3	
	85%	65%	23%	Readiness with the applicable craft down for Availibility							
	70%	53%	19%	Readiness with all craft assigned to the ACU							

Table 8. Advanced Table

APPENDIX B. ADDITIONAL BACKGROUND INFORMATION

A. OTHER UNITS IN NAVAL BEACH GROUP ONE (NBG – 1)

1. Assault Craft Unit (ACU – 5)

ACU-5 operates Landing Craft Air Cushioned (LCAC) hovercrafts out of its base at Marine Corps Base Camp Pendleton located in North San Diego County, California. The LCAC is designed to deliver the assault elements of a Marine Ground Force from Naval amphibious ships lying offshore into the beach area at high speed. Powered by four gas turbine engines, these craft can carry a payload of 60 – 75 tons over a distance of 200 nautical miles at speeds in excess of 40 knots (U.S. Navy, 2007). While not designed to conduct landings under fire, LCACs are outfitted with a number of small arms including .50 caliber machine guns and 40mm grenade launchers (U.S. Navy, 2007). More recently LCACs have been used to deliver relief supplies to disaster areas around the world.

LCACs were first placed into service with the U.S. Navy in 1986. Avondale Gulfport Marine and Textron Marine and Land Systems were given two separate 15 craft orders for initial production. Upon delivery of the initial orders Textron Marine was awarded the contract for the remainder of production that has totaled 91 craft, the last one being delivered in 2001 (Saunders, 2008). The Navy has initiated a Service Life Extension Program (SLEP), an overhaul program that returns the craft to the manufacturer where it is updated and rebuilt to allow the craft to operate for an additional ten years past the original service life. Using the last craft delivered as a model (LCAC 91), three craft have been returned to fleet service so far (U.S. Navy, 2007).

LCACs operate from specially designed U.S. Navy amphibious ships equipped with an internal well deck. These ships include Amphibious Assault Ships (LHA/LHD), Amphibious Transport Docks (LPD), and Dock Landing Ships (LSD). These ships have the capability to operate alone or as part of an Amphibious Ready Group (ARG). An ARG consists of an LHA/LHD, LPD and LSD. A typical ARG will deploy with a detachment of three to five LCACs, each with five crew members, maintenance personnel, and an Officer-in-Charge (OIC) under the ARG commander (U.S. Navy, 2007).

2. Beachmaster Unit ONE (BMU – 1)

BMU-1 is located at Naval Amphibious Base Coronado, California. Beachmaster Unit ONE is the Naval Element of the Landing Force Shore Party (LFSP). The Beachmaster unit describes its mission as:

> The mission of BMU-1 is to support the landing movement over the beaches of troops, equipment and supplies, and to facilitate the evacuation of casualties and prisoners of war. In addition, the Beachmasters maintain communications and liaison with designated naval commanders and naval control units, control all craft and amphibious vehicles in the vicinity of the beach from the surf line to the high water mark, coordinate the reembarkation of equipment, troops and supplies, determine and advise on the suitability for landing through coordination with the Oceanographic Section of the Sea, Air, Land (SEAL TEAM), control craft salvage, keep appropriate Navy commanders apprised of wind and surf conditions, install causeway beaching range markers lights, and assist in the defense of the beach. (Beachmaster-1, 2008)

3. Amphibious Construction Battalion (ACB – 1)

Based out of Naval Amphibious Base Coronado, California, ACB-1 is the support element of the Naval Construction Force, better known as the SeaBees, for amphibious operations in the Pacific Fleet. These SeaBees are trained to build facilities in support of the operations on shore with no established infrastructure. They are trained in construction disciplines such as steelwork, electrical, and equipment operations as well as ground combat skills. Their Motto, “We Build, We Fight,” is a testament to their ability to operate in hostile environments where they need to provide their own security and in some cases fight as infantrymen.

SeaBees can build camp facilities to support up to 1,200 personnel, Roll-on/Roll-off discharge facilities, Causeway Bridge Ferry Transport Systems, Amphibious Assault Bulk Fuel/Water Systems and Offshore Discharge Systems, and over 300 pieces of Civil Engineering Support Equipment (CESE) (ACB TWO, 2008). Outside of their main responsibilities, SeaBees have gained a reputation for being able to handle many problems outside of their general responsibilities and are often counted on to build or fix any structure to help support the missions of the forces they are attached to. A valuable fixture to any amphibious operation the SeaBees have also become a fixture of relief operations around the world.

B. MAKEUP OF ARG

An Amphibious Ready Group (ARG) is a Navy flotilla of ships specifically designed for the transport and support of Marine Corps forces trained to conduct amphibious landings on foreign shores (U.S. Navy 2007). The ARG generally consists of three ships, each of a different ship type, which embarks the Marine Expeditionary Unit (MEU) for a roughly six month deployment to the Pacific or Mediterranean.

The centerpiece of the ARG is the LHD/LHA. These are aircraft capable ships that look similar to World War II era Aircraft Carriers (U.S. Navy 2007). The Marines Air Combat Element (ACE) is a combined squadron of 28 aircraft that embarks the LHD/LHA to offer aviation support to the MEU (U.S. Navy 2007). The squadron consists of different aircraft types to support the various requirements of the MEU. A typical squadron consists of 12 CH-46D Sea Knight helicopters for troop/supply missions, six AV-8B Harrier II's for close in ground support, four CH-53E Super Stallion helicopters for troop/supply support, four AH-1W Super Cobra attack helicopters for close in ground support, and two UH-1W Iroquois command and control helicopters (U.S. Navy 2007). The LHD/LHA also contains a vehicle storage area and berthing for a number of Marine equipped with an internal well-deck to embark various landing craft and serves as the command ship for the ARG and MEU commanders (U.S. Navy 2007).

In addition to the LHD/LHA are one each of an LPD and an LSD (U.S. Navy 2007). While each has a slightly different configuration, both are designed to carry Marines and landing craft. An LPD can carry two LCACs or a single LCU while most LSDs, specifically designed to carry LCACs, can carry as many as four (U.S. Navy 2007).

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APPENDIX C. AN ALTERNATIVE DETERMINATION OF DEPLOYED OPERATING HOURS

The authors were able to create an alternate estimate of the number of deployed operating hours after obtaining the DEI reports. DEI reports were used because they provide an accurate measure of the number of hours the main propulsion Diesel engines operate over a given period of time. DEI reports can cover a period of time which is based upon when the DEI actually occurs. DEIs occur on a roughly 18 month cycle, but can vary by up to two months based on historical data. Subtracting the OPSUMs local operating hours from the total Diesel engine hours provides an estimate of the operating hours completed on deployment. Dividing these estimated hours by craft on deployment provides an estimate of the average operating hours, by craft on deployment.

Since it was not possible to determine individual craft deployed hours via the DEI reports, the authors performed an analysis to determine the *average* monthly Diesel engine operating hours. This was done be summing the total hours reported on all the Diesel inspections received, and dividing by the total months for all the same reports. The result is an average of 28.0 hours per craft per month. This represents the total hours operated, on average, by a single craft per month. Multiplying the result by 8.25, the average number of craft operating throughout 2006–2008, and by 36 months, results in an estimate of the total hours operated by all craft during this period. Removing the hours for local operations and dividing by the average deployed craft during the same period, and adjusting the total to a monthly basis, results in an average deployed craft operating hours of 12.25 hours / month. This calculation is shown in Table 10. Using the average deployed operating hours by craft per month, it was possible then to apply this average amount to the actual craft deployed on a monthly basis over the years of 2006 – 2008. The result is shown in Figure 14, with the Total operating hours depicted by the black dash-dotted line. The linear regression model is plotted against actual SR expenditures in Figure 15, with a correlation of 0.429.

CRAFT	DATE	PORT MPDE	STBD MPDE	Min MPDE	months
LCU 1617	OCT 2005-MAY 2008	993	1044	993	32
LCU 1629	DEC 2004-APR 2008	865	864	864	41
LCU 1630	JUL 2005-SEP 2008	1051	1034	1034	39
LCU 1632	APR 2005-JAN 2008	559	574	559	34
LCU 1633	JUN 2005 MAR 2008	1384	1212	1212	34
LCU 1635	NOV 2004-AUG 2008	1824	1671	1671	46
LCU 1648	SEP 2005-NOV 2008	1117	1126	1117	39
LCU 1665	APR 2005-JUN2008	1206	1198	1198	39
LCU 1666	NOV 2004-APR 2009	1525	1512	1512	54
LCU 1630	MAY 2005-JUL 2008	939	982	939	39

Table 9. Diesel Engine Inspection reports, San Diego (Appendix E, Table 32)

CRAFT	DATE	PORT MPDE	STBD MPDE	Min MPDE	months
LCU 1646	MAY 2006-APR 2009	811	807	807	55
LCU 1627	JUN 2005-JUL 2008	868	848	848	38
LCU 1634	AUG2004-MAR 2009	1990	2002	1990	56
LCU 1651	AUG 2004-MAR 2009	424	792	424	56

Table 10. Diesel Engine Inspection reports, Sasebo (Appendix E, Table 32)

Total Diesel Operating hours		11,099	Hours
Total Diesel Operating months	/	397	Months
Average Diesel Operating hours by month		28.0	Hours / Month
Average Operating craft		8.25	Craft
36 months	x	36	Months
Diesel hours 2006 - 2008		8,299	Hours
Local Operating hours 2006 - 2008	-	6,353	Hours
Deployed Diesel hours 2006 - 2008		1,947	Hours
Average Deploying craft		4.41	Craft
36 months	/	36	Months
Average Deploying craft hours by month		12.25	Hours / Craft / Month

Table 11. Summation of Deployed Hours Calculation by Means of Diesel Engine Inspection Reports (Appendix E, Table 32)

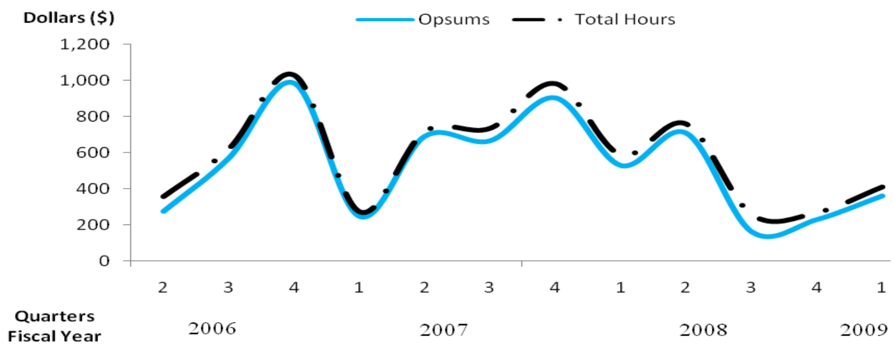

Figure 14. Total Operating Hours, Based on Deployed Hours via Diesel Inspection Reports (Appendix D, Table 24)

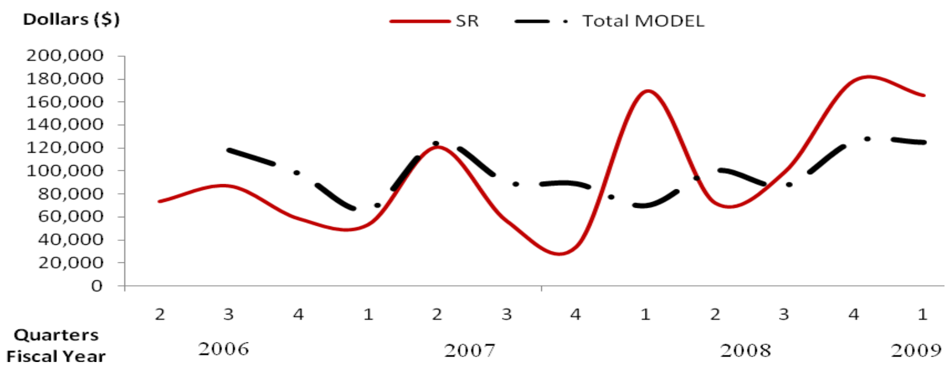

Figure 15. Diesel Engine Inspection Report Derived Total Hour SR Expenditure Model vs. Actual SR Expenditure data (Appendix D, Table 24)

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APPENDIX D. PROCESSED DATA TABLES

Date	OPSUM (hours)	SR ($)
Jan-06	63	14,179
Feb-06	72.5	34,057
Mar-06	142	25,308
Apr-06	176.5	35,747
May-06	201.5	20,345
Jun-06	194.5	30,908
Jul-06	97	25,205
Aug-06	662	22,145
Sep-06	227	11,260
Oct-06	80	38,961
Nov-06	71	13,627
Dec-06	98.5	782
Jan-07	231	40,297
Feb-07	246	48,255
Mar-07	216	32,194
Apr-07	144	24,228
May-07	86	14,821
Jun-07	438	17,391
Jul-07	67	14,393
Aug-07	647	10,256
Sep-07	191	9,619
Oct-07	226	49,623
Nov-07	214	80,711
Dec-07	91	38,951
Jan-08	374	32,806
Feb-08	122	23,030
Mar-08	214	16,367
Apr-08	78	14,784
May-08	41	49,939
Jun-08	46	34,368
Jul-08	44	177,558
Aug-08	74	10,430
Sep-08	114	(9,491)
Oct-08	118	23,546
Nov-08	202	51,997
Dec-08	43	90,132

Table 12. Original Local Operating Hours and SR Expenditure Data (Appendix D, Table 25, Appendix E, Table 27)

FY year	Quarter	OPSUMS (hours)	SR ($)
2006	2	278	73,544
	3	573	87,001
	4	986	58,610
2007	1	250	53,370
	2	693	120,746
	3	668	56,439
	4	905	34,268
2008	1	531	169,285
	2	710	72,203
	3	165	99,091
	4	232	178,497
2009	1	363	165,675

Table 13. Local Operating Hours and SR Expenditure Data (Appendix D, Table 21 and Appendix D, Table 22)

FY year	Quarter	OPSUMS (hours)	SR Shift Left ($)
2006	2	278	87,001
	3	573	58,610
	4	986	53,370
2007	1	250	120,746
	2	693	56,439
	3	668	34,268
	4	905	169,285
2008	1	531	72,203
	2	710	99,091
	3	165	178,497
	4	232	165,675
2009	1	363	

Table 14. Local Operating Hours and SR Expenditure Data Shifted Left (Appendix D, Table 21 and Appendix D, Table 22)

FY year	Quarter	OPSUMS (hours)	SR Shift Left ($)
2006	2	278	87,001
	3	573	58,610
	4	986	53,370
2007	1	250	120,746
	2	693	56,439
	3		
	4		
2008	1		
	2		
	3		
	4		
2009	1		

Table 15. Local Operating Hours and SR Expenditure Data Shifted Left, First Five Quarters Only (Appendix D, Table 21 and Appendix D, Table 22)

FY year	Quarter	Deployed craft	SR ($)
2006	2	6.5	73,544
	3	4.0	87,001
	4	3.5	58,610
2007	1	1.9	53,370
	2	2.1	120,746
	3	5.5	56,439
	4	6.3	34,268
2008	1	4.6	169,285
	2	4.0	72,203
	3	7.6	99,091
	4	3.0	178,497
2009	1	3.9	165,675

Table 16. Deployed Craft and SR Expenditure Data (Appendix D, Table 21 and Appendix D, Table 22)

FY year	Quarter	Deployed craft	SR Shift Left ($)
2006	2	6.5	87,001
	3	4.0	58,610
	4	3.5	53,370
2007	1	1.9	120,746
	2	2.1	56,439
	3	5.5	34,268
	4	6.3	169,285
2008	1	4.6	72,203
	2	4.0	99,091
	3	7.6	178,497
	4	3.0	165,675
2009	1	3.9	

Table 17. Deployed Craft and SR Expenditure Data Shifted Left (Appendix D, Table 21 and Appendix D, Table 22)

FY year	Quarter	Deployed craft	SR Shift Left ($)
2006	2		
	3		
	4		
2007	1		
	2		
	3	5.5	34,268
	4	6.3	169,285
2008	1	4.6	72,203
	2	4.0	99,091
	3	7.6	178,497
	4		
2009	1		

Table 18. Deployed Craft and SR Expenditure Data Shifted Left, First Five Quarters Only (Appendix D, Table 21 and Appendix D, Table 22)

FY year	Quarter	OPSUMS (hours)	Local Operating Hour Model ($)	In port fraction	In port SR ($)
2006	2	278		0.31	
	3	573	97,075	0.54	30,068
	4	986	73,914	0.61	40,165
2007	1	250	41,449	0.79	25,296
	2	693	99,274	0.73	77,974
	3	668	64,453	0.39	47,339
	4	905	66,416	0.19	25,829
2008	1	531	47,809	0.47	9,155
	2	710	77,172	0.48	35,984
	3	165	63,119	0.09	30,471
	4	232	105,908	0.55	9,724
2009	1	363	100,648	0.43	54,899
		Intercept	118,863	Fit - LOHM	69.8%
		Slope	(78.51)	Fit - DCM	47.0%

FY year	Quarter	Deployed craft	Deployed Craft Model ($)	Deploy fraction	Deploy SR ($)
2006	2	6.5		0.69	
	3	4.0	137,609	0.46	94,987
	4	3.5	63,222	0.39	28,867
2007	1	1.9	48,143	0.21	18,762
	2	2.1	(610)	0.27	(131)
	3	5.5	3,913	0.61	1,039
	4	6.3	107,452	0.81	65,665
2008	1	4.6	132,583	0.53	107,195
	2	4.0	80,814	0.52	43,132
	3	7.6	62,217	0.91	32,181
	4	3.0	170,279	0.45	154,645
2009	1	3.9	32,060	0.57	14,573
		Intercept	(58,411)	Fit - CSREP	57.0%
		Slope	30,157	Fit - TEE	59.7%

FY year	Quarter	Combined SR Expenditure Projection ($)	SR ($)
2006	2		73,544
	3	125,054	87,001
	4	69,032	58,610
2007	1	44,058	53,370
	2	77,843	120,746
	3	48,378	56,439
	4	91,494	34,268
2008	1	116,350	169,285
	2	79,116	72,203
	3	62,652	99,091
	4	164,369	178,497
2009	1	69,471	165,675

Table 19. CSREP (Weighted LOHM and DCM) vs. SR Expenditures (Appendix D, Table 21 and Appendix D, Table 22)

FY year	Quarter	Combined SR Expenditures Projection ($)	CSREP converted to include Sasebo ($)	Total Expenditures Estimate ($)	Total Actual Expenditures ($)
2006	2				240,164
	3	125,054	215,611	616,032	255,418
	4	69,032	119,021	340,059	341,477
2007	1	44,058	75,962	217,035	224,667
	2	77,843	134,213	383,465	298,388
	3	48,378	83,411	238,318	355,140
	4	91,494	157,748	450,708	1,124,385
2008	1	116,350	200,603	573,151	462,767
	2	79,116	136,406	389,733	466,602
	3	62,652	108,021	308,631	726,344
	4	164,369	283,395	809,699	1,428,244
2009	1	69,471	119,778	342,223	360,138
Conversion Factor for Sasebo			1.72	Fit	59.7%
Conversion Factor for SR -> Total expenditures				35%	

Table 20. Derivation of TQEE; TQEE vs. Actual Expenditure data (Appendix D, Table 21 and Appendix D, Table 22)

Fiscal Year	Quarter	SR ($)	SC ($)	Total ($)	SR (Adjusted for Inflation) ($)	SC (Adjusted for Inflation) ($)	Total (Adjusted for Inflation) ($)
2006	2	68,900	228,888	224,999	73,544	244,315	240,164
	3	81,507	66,286	239,289	87,001	70,753	255,418
	4	54,909	124,156	319,915	58,610	132,524	341,477
2007	1	50,000	73,005	210,481	53,370	77,926	224,667
	2	116,169	92,875	287,078	120,746	96,534	298,388
	3	54,300	116,673	341,678	56,439	121,270	355,140
	4	32,969	438,759	1,081,763	34,268	456,047	1,124,385
2008	1	162,868	161,380	445,226	169,285	167,738	462,767
	2	71,136	282,617	459,706	72,203	286,857	466,602
	3	97,627	485,843	715,609	99,091	493,131	726,344
	4	175,859	701,380	1,407,137	178,497	711,900	1,428,244
2009	1	163,227	377,320	354,816	165,675	382,980	360,138

Table 21. Quarterly Original OPTAR expenditure Data and Converted Values for Inflation (Appendix E, Table 27)

Fiscal Year	Quarter	Original (hours)	OPSUMS (hours)	In port	DEI	CMAV	DPMA	Deploy
2006	2	101	93	2.9	0.2	0.0	0.4	6.5
	3	183	191	4.8	0.0	0.3	0.9	4.0
	4	328	329	5.5	0.0	0.3	0.7	3.5
2007	1	106	83	7.0	0.1	0.0	1.0	1.9
	2	226	231	5.7	0.0	1.2	1.0	2.1
	3	331	223	3.5	0.0	0.0	1.0	5.5
	4	334	302	1.5	0.0	0.9	1.3	6.3
2008	1	198	177	4.0	0.3	0.2	0.9	4.6
	2	199	237	3.7	0.3	1.0	1.0	4.0
	3	85	55	0.8	0.7	0.3	0.8	7.6
	4	141	77	3.6	0.6	1.5	1.3	3.0
2009	1	128	121	2.9	0.0	1.3	1.9	3.9

Table 22. Quarterly San Diego Craft Allotments, Original and Updated Local Operating Hours (Appendix D, Table 25)

Fiscal Year	Quarter	In port	DEI	CMAV	DPMA	Deploy
2006	2	2.9	0.0	0.0	0.0	1.2
	3	2.5	0.0	0.0	0.2	1.3
	4	3.3	0.0	0.0	0.8	0.0
2007	1	2.0	0.7	0.0	0.0	1.3
	2	2.9	0.4	0.0	0.0	0.7
	3	3.7	0.0	0.0	0.0	0.3
	4	3.8	0.2	0.0	0.0	0.0
2008	1	3.0	0.0	0.0	0.8	0.0
	2	3.0	0.0	0.8	0.2	0.0
	3	2.8	0.0	0.0	1.2	0.0
	4	1.0	0.5	0.4	1.8	0.3
2009	1	0.7		0.8	1.5	1.0

Table 23. Quarterly Sasebo Craft Allotments (Appendix D, Table 26)

FY year	Quarter	Deployed craft	OPSUMS (hours)	Deploy (hours)	Total Hours
2006	2	6.5	278	79.7	357
	3	4.0	573	49.4	622
	4	3.5	986	43.3	1,029
2007	1	1.9	250	23.5	273
	2	2.1	693	25.3	718
	3	5.5	668	67.4	735
	4	6.3	905	77.6	983
2008	1	4.6	531	56.6	588
	2	4.0	710	49.0	759
	3	7.6	165	92.9	258
	4	3.0	232	36.8	269
2009	1	3.9	363	47.4	410
		Average Diesel hours / month / craft		12.25	

FY year	Quarter	Total MODEL ($)	SR ($)
2006	2		73,544
	3	118,299	87,001
	4	97,801	58,610
2007	1	66,264	53,370
	2	124,815	120,746
	3	90,339	56,439
	4	89,017	34,268
2008	1	69,879	169,285
	2	100,461	72,203
	3	87,188	99,091
	4	125,981	178,497
2009	1	125,142	165,675
Intercept		145,949	
Slope		(77.42)	

Table 24. Total Hours Determination Based on DEI Reports vs. SR Expenditure Data (Appendix D, Table 21 and Appendix D, Table 22)

$$\left(\begin{array}{c}\dfrac{\left((118{,}863)+\left(In\_port\_hours\right)*\left(-78.51\right)\right)*\left(In\_port\_craft\right)}{\left(craft\_deployed+In\_port\_craft\right)*0.35}\\+\\\dfrac{\left((-58{,}411)+\left(craft\_deployed\right)*\left(30{,}157\right)\right)*\left(craft\_deployed\right)}{\left(craft\_deployed+In\_port\_craft\right)*0.35}\end{array}\right)*\left(\frac{1}{(0.35)*(1-0.42)}\right) \tag{1.3}$$

$$= Yearly\_Budget$$

* All values are obtained from the previous quarter (@ t – 1).

	Original (hours)	OPSUMS (hours)	In port	DEI	CMAV	DPMA	Deploy
Jan-06	76	63	1	0.5	0	1	7.5
Feb-06	84	72.5	1.75	0	0	0.25	8
Mar-06	143	142	6	0	0	0	4
Apr-06	175	176.5	5	0	0.75	0.75	3.5
May-06	210	201.5	5	0	0	1	4
Jun-06	166	194.5	4.4	0	0	1	4.6
Jul-06	97	97	4	0	0	1	5
Aug-06	808	662	5	0	0	1	4
Sep-06	80	227	7.6	0	0.8	0	1.6
Oct-06	87	80	7.25	0	0	1	1.75
Nov-06	177	71	7	0	0	1	2
Dec-06	54	98.5	6.8	0.2	0	1	2
Jan-07	225	231	5.75	0	1.25	1	2
Feb-07	236	246	5	0	2	1	2
Mar-07	216	216	6.4	0	0.4	1	2.2
Apr-07	156	144	6	0	0	1	3
May-07	409	86	3.5	0	0	1	5.5
Jun-07	428	438	1	0	0	1	8
Jul-07	67	67	1.25	0	2	1.75	5
Aug-07	749	647	2	0	0	1	7
Sep-07	187	191	1.25	0	0.75	1	7
Oct-07	246	226	3	0	0.5	1	5.5
Nov-07	256	214	4.6	0	0	0.8	4.6
Dec-07	91	91	4.5	0.75	0	1	3.75
Jan-08	311	374	5.25	0	0.75	1	3
Feb-08	146	122	3.2	0.8	2	1	3
Mar-08	140	214	2.75	0	0.25	1	6
Apr-08	126	78	0.5	1	0.75	1	6.75
May-08	58	41	0.8	0.2	0	1	8
Jun-08	71	46	1	0.75	0	0.25	8
Jul-08	210	44	4.5	0.75	0.75	1	3
Aug-08	102	74	3.8	1	1.2	1	3
Sep-08	112	114	2.5	0	2.5	2	3
Oct-08	164	118	1.4	0	2	2	4.6
Nov-08	144	202	1.75	0	1.25	2	5
Dec-08	75	43	5.5	0	0.75	1.75	2

Table 25. San Diego Craft Allotments, Original and Updated Local Operating Hours (After: ACU-1, 2006) (After: ACU-1, 2007) (After: ACU-1, 2008)

	In port	DEI	CMAV	DPMA	Deploy
Jan-06	3.5	0	0	0	0.5
Feb-06	2.25	0	0	0	1.75
Mar-06	2.8	0	0	0	1.2
Apr-06	2.5	0	0	0	1.5
May-06	2	0	0	0.5	1.5
Jun-06	3	0	0	0.2	0.8
Jul-06	3.75	0	0	0.25	0
Aug-06	3	0	0	1	0
Sep-06	3	0	0	1	0
Oct-06	2	0	0	0	2
Nov-06	2	0	0	0	2
Dec-06	2	2	0	0	0
Jan-07	3.25	0.75	0	0	0
Feb-07	3.5	0	0	0	0.5
Mar-07	2	0.4	0	0	1.6
Apr-07	3	0	0	0	1
May-07	4	0	0	0	0
Jun-07	4	0	0	0	0
Jul-07	4	0	0	0	0
Aug-07	3.4	0.6	0	0	0
Sep-07	4	0	0	0	0
Oct-07	3	0	0	1	0
Nov-07	3	0	0	0.4	0
Dec-07	3	0	0	1	0
Jan-08	3	0	0.5	0.5	0
Feb-08	3	0	1	0	0
Mar-08	3	0	1	0	0
Apr-08	4	0	0	0	0
May-08	2.4	0	0	1.6	0
Jun-08	2	0	0	2	0
Jul-08	0.5	1	0.5	2	0
Aug-08	1.6	0.4	0	2	0
Sep-08	1	0	0.75	1.5	0.75
Oct-08	0	0	1	2	1
Nov-08	0	0	1	2	1
Dec-08	2	0	0.5	0.5	1

Table 26. Sasebo Craft Allotments (After: ACU-1, 2006) (After: ACU-1, 2007) (After: ACU-1, 2008)

APPENDIX E. RAW DATA TABLES

	SR ($)	SC ($)	Total ($)	Inflation adjust-ment	SR (Adjusted for Inflation) ($)	SC (Adjusted for Inflation) ($)	Total (Adjusted for Inflation) ($)
Jan-06	13,284	149,923	52,269	1.0674	14,179	160,028	55,792
Feb-06	31,906	49,052	107,461	1.0674	34,057	52,358	114,704
Mar-06	23,710	29,912	65,270	1.0674	25,308	31,928	69,669
Apr-06	33,490	22,118	99,690	1.0674	35,747	23,608	106,410
May-06	19,060	11,956	64,312	1.0674	20,345	12,762	68,647
Jun-06	28,957	32,212	75,287	1.0674	30,908	34,383	80,361
Jul-06	23,614	15,148	67,063	1.0674	25,205	16,169	71,583
Aug-06	20,746	73,113	217,032	1.0674	22,145	78,041	231,660
Sep-06	10,549	35,895	35,820	1.0674	11,260	38,315	38,234
Oct-06	36,501	29,349	128,188	1.0674	38,961	31,327	136,828
Nov-06	12,767	24,161	60,371	1.0674	13,627	25,790	64,440
Dec-06	733	19,495	21,921	1.0674	782	20,808	23,399
Jan-07	38,769	46,775	126,587	1.0394	40,297	48,618	131,575
Feb-07	46,426	28,464	99,062	1.0394	48,255	29,586	102,965
Mar-07	30,973	17,636	61,429	1.0394	32,194	18,331	63,849
Apr-07	23,310	44,336	102,437	1.0394	24,228	46,083	106,473
May-07	14,259	25,268	81,586	1.0394	14,821	26,263	84,801
Jun-07	16,731	47,070	157,655	1.0394	17,391	48,924	163,866
Jul-07	13,848	14,247	137,073	1.0394	14,393	14,809	142,474
Aug-07	9,867	226,494	514,351	1.0394	10,256	235,417	534,617
Sep-07	9,254	198,019	430,339	1.0394	9,619	205,821	447,294
Oct-07	47,742	33,815	122,140	1.0394	49,623	35,148	126,952
Nov-07	77,652	81,917	196,360	1.0394	80,711	85,144	204,097
Dec-07	37,474	45,648	126,726	1.0394	38,951	47,446	131,719
Jan-08	32,321	71,071	114,674	1.0150	32,806	72,137	116,395
Feb-08	22,690	100,835	160,747	1.0150	23,030	102,348	163,158
Mar-08	16,125	110,711	184,284	1.0150	16,367	112,372	187,049
Apr-08	14,566	65,918	164,095	1.0150	14,784	66,907	166,556
May-08	49,201	392,139	466,449	1.0150	49,939	398,022	473,446
Jun-08	33,860	27,786	85,065	1.0150	34,368	28,203	86,341
Jul-08	174,934	308,043	578,716	1.0150	177,558	312,664	587,397
Aug-08	10,276	304,291	473,314	1.0150	10,430	308,856	480,414
Sep-08	(9,351)	89,045	355,107	1.0150	(9,491)	90,381	360,433
Oct-08	23,198	68,961	127,965	1.0150	23,546	69,995	129,884
Nov-08	51,229	130,346	134,376	1.0150	51,997	132,301	136,392
Dec-08	88,800	178,013	92,475	1.0150	90,132	180,683	93,862

Table 27. Original OPTAR Expenditure Data and Converted Values for Inflation (After: 1C6C, 2006) (After: 1C6C, 2007) (After: 1C6C, 2008)

	January				February				March					April			
	6	13	20	27	3	10	17	24	3	10	17	24	31	7	14	21	28
Workups	0	28	0	6	5	9	7	5	0	0	3	7	8.5	58	84	11	8
Training	0	0	6	0	13	0	2	0	0	5	0	0	0	0	0	0	8
Servalls	0	4	14	5	0	15	5	12	48	32	22	17	0	0	0	6	2
Totals	0	32	20	11	18	24	14	17	48	37	25	24	8.5	58	84	17	18
	San Diego																
In port	1	1	1	1	1	2	2	2	2	7	7	7	7	7	6	3	4
DEI	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CMAV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
DPMA	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1
Deploy	7	7	8	8	8	8	8	8	8	3	3	3	3	3	3	4	4
	Sasebo																
In port	4	4	4	2	3	2	2	2	2	2	4	4	2	2	2	2	4
DEI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DPMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CMAV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deploy	0	0	0	2	1	2	2	2	2	2	0	0	2	2	2	2	0

	May				June					July				August			
	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25
Workups	0	0	0	0	0	0	10	0	0	0	74	0	0	14	246	96	11
Training	0	0	3	25	6	5	0	0	0	5	0	0	0	0	8	0	0
Servalls	110	14	0	50	16	8	0	35	115	0	0	14	4	10	38	31	208
Totals	110	14	3	75	22	13	10	35	115	5	74	14	4	24	292	127	219
	San Diego																
In port	5	5	5	5	5	5	4	4	4	4	4	4	4	5	5	5	5
DEI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CMAV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DPMA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Deploy	4	4	4	4	4	4	5	5	5	5	5	5	5	4	4	4	4
	Sasebo																
In port	4	2	1	1	1	2	4	4	4	4	4	4	3	3	3	3	3
DEI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DPMA	0	0	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1
CMAV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deploy	0	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0

	September					October				November				December				
	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29
Workups	0	30	0	1.5	1.5	9	3	7	0	0	0	7.5	7.5	45	0	0	0	0
Training	0	6	0	0	0	0	0	24	6	6	0	5.5	5.5	6	16	4	7	4
Servalls	148	0	25	7.5	7.5	23	0	0	8	16	23	0	0	0	8	9	0	0
Totals	148	36	25	9	9	32	3	31	14	22	23	13	13	51	24	13	7	4
	San Diego																	
In port	6	8	8	8	8	8	7	7	7	7	7	7	7	7	7	7	7	6
DEI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
CMAV	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
DPMA	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Deploy	4	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
	Sasebo																	
In port	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2
DEI	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2
DPMA	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
CMAV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deploy	0	0	0	0	0	2	2	2	2	2	2	2	2	0	0	0	0	0

Table 28. Raw OPSUM 2006 Data (After: ACU-1, 2006)

	January				February				March					April			
	5	12	18	26	2	9	16	23	2	9	16	23	30	6	13	20	27
Workups	0	8	48	102	0	11	0	0	8	4	83	7	43	8	18	19	38
Training	8	4	18	4	8	8	6	4	10	15	0	5	7	0	0	12	0
Servalls	0	28	6	5	24	35	137	13	4	10	0	5	15	0	19	23	7
Totals	8	40	72	111	32	54	143	17	22	29	83	17	65	8	37	54	45
	San Diego																
In port	7	6	6	4	5	5	5	5	6	6	7	7	6	6	6	6	6
DEI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CMAV	0	1	1	3	2	2	2	2	1	1	0	0	0	0	0	0	0
DPMA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Deploy	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3
	Sasebo																
In port	3	3	3	4	4	4	4	2	3	1	2	2	2	2	2	4	4
DEI	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0
CMAV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DPMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deploy	0	0	0	0	0	0	0	2	0	2	2	2	2	2	2	0	0

	May				June					July				August				
	4	11	18	25	1	8	17	22	29	6	13	20	27	3	10	17	24	31
Workups	0	0	13	3	48	0	0	3	264	0	0	0	0	0	5	0	3	0
Training	4	0	6	0	0	10	26	64	0	4	1	7	8	4	0	0	0	8
Servalls	11	17	13	19	7	5	0	11	0	6	0	11	30	34	58	336	178	21
Totals	15	17	32	22	55	15	26	78	264	10	1	18	38	38	63	336	181	29
	San Diego																	
In port	6	6	1	1	1	1	1	1	1	2	1	1	1	2	2	2	2	2
DEI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CMAV	0	0	0	0	0	0	0	0	0	2	2	2	2	0	0	0	0	0
DPMA	1	1	1	1	1	1	1	1	1	1	2	2	2	1	1	1	1	1
Deploy	3	3	8	8	8	8	8	8	8	5	5	5	5	7	7	7	7	7
	Sasebo																	
In port	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	4	4
DEI	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
CMAV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DPMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deploy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	September				October				November					December			
	7	14	21	28	5	12	18	26	2	9	16	23	30	7	14	21	28
Workups	31	0	0	17	0	8	0	0	30	7	60	0	0	0	0	0	0
Training	0	14	12	0	14	0	0	0	0	13	0	20	0	0	18	15	0
Servalls	96	8	0	13	8	12	134	50	0	0	48	0	36	58	0	0	0
Totals	127	22	12	30	22	20	134	50	30	20	108	20	36	58	18	15	0
	San Diego																
In port	2	1	1	1	1	1	5	5	5	5	4	4	5	4	4	4	6
DEI	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
CMAV	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
DPMA	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1
Deploy	7	7	7	7	7	7	4	4	4	4	5	5	5	4	4	4	3
	Sasebo																
In port	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3
DEI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CMAV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DPMA	0	0	0	0	1	1	1	1	1	1	0	0	0	1	1	1	1
Deploy	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0

Table 29. Raw OPSUM 2007 Data (After: ACU-1, 2007)

	January				February					March				April			
	4	11	17	25	1	8	15	22	29	7	14	21	28	4	11	18	25
Workups	0	0	296	0	6	0	2	0	4	12	16	0	4	20	10	16	0
Training	0	10	2	66	6	7	5	21	8	8	0	0	0	0	8	16	0
Servalls	0	0	0	0	6	32	21	16	48	8	40	30	36	0	0	8	0
Totals	0	10	298	66	18	39	28	37	60	28	56	30	40	20	18	40	0
	San Diego																
Inport	6	6	6	3	3	2	3	4	4	3	3	3	2	1	1	0	0
DEI	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
CMAV	0	0	0	3	3	3	2	1	1	0	0	0	1	1	1	1	0
DPMA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Deploy	3	3	3	3	3	3	3	3	3	6	6	6	6	6	6	7	8
	Sasebo																
Inport	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4
DEI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CMAV	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
DPMA	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deploy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	May					June				July				August				
	2	9	18	23	30	6	13	20	27	4	11	18	25	1	8	15	22	29
Workups	12	0	10	0	0	0	12	0	0	8	0	6	6	5	5	0	6	0
Training	4	0	0	0	7	0	0	0	0	0	0	6	6	0	0	7	0	0
Servalls	4	0	8	3	0	0	27	0	0	0	0	6	6	13	13	0	13	12
Totals	20	0	18	3	7	0	39	0	0	8	0	18	18	18	18	7	19	12
	San Diego																	
Inport	0	1	1	1	1	1	1	1	1	6	4	4	4	3	4	4	4	4
DEI	1	0	0	0	0	0	1	1	1	0	1	1	1	2	1	1	1	0
CMAV	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	2
DPMA	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1
Deploy	8	8	8	8	8	8	8	8	8	3	3	3	3	3	3	3	3	3
	Sasebo																	
Inport	4	2	2	2	2	2	2	2	2	0	0	1	1	0	2	2	2	2
DEI	0	0	0	0	0	0	0	0	0	2	2	0	0	2	0	0	0	0
CMAV	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
DPMA	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Deploy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	September				October					November				December			
	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19	26
Workups	0	3	6	54	46	0	0	0	0	16	6	0	0	15	0	0	0
Training	0	18	6	2	6	8	5	8	10	10	6	16	0	3	0	10	0
Servalls	10	5	6	4	12	22	5	6	36	0	6	42	54	15	0	0	0
Totals	10	26	18	60	64	30	10	14	46	26	18	58	54	33	0	10	0
	San Diego																
Inport	2	2	3	3	3	1	1	1	1	1	2	2	2	5	5	6	6
DEI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CMAV	3	3	2	2	2	2	2	2	2	2	1	1	1	1	1	0	1
DPMA	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
Deploy	3	3	3	3	3	5	5	5	5	5	5	5	5	2	2	2	2
	Sasebo																
Inport	4	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	3
DEI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CMAV	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
DPMA	0	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0
Deploy	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 30. Raw OPSUM 2008 Data (After: ACU-1, 2008)

1629	09/08 through 02/09	$2,360,842.00
1665	06/08 through 11/08	$2,030,383.00
1617	12/07 through 06/08	$2,500,00.00
1633	07/07 through 11/07	$1,951,286.00
1666	03/07 through 08/07	$2,196,401.00
1630	09/06 through 02/07	$1,987,100.00
1648	03/06 through 08/06	$1,835,457.00
1632	08/05 through 12/05	$1,273,380.00
1665	12/04 through 02/05	$1,117,736.00
1629	08/04 through 10/04	$1,147,013.00
1633	09/03 through 10/03	$1,148,970.00
1617	06/03 through 08/03	$1,340,930.00
1646	02/03 through 03/03	$362,168.00
1630	01/03 through 01/03	$276,304.00
1632	10/02 through 11/02	$140,672.00

Table 31. DPMA Cost and Schedule Data From 2003 – 2008 (From: James, 2009)

CRAFT	**DATE**	**PORT MPDE**	**STBD MPDE**	**Min MPDE**	**months**
LCU 1617	OCT 2005-MAY 2008	993	1044	993	32
LCU 1629	DEC 2004-APR 2008	865	864	864	41
LCU 1630	JUL 2005-SEP 2008	1051	1034	1034	39
LCU 1632	APR 2005-JAN 2008	559	574	559	34
LCU 1633	JUN 2005 MAR 2008	1384	1212	1212	34
LCU 1635	NOV 2004-AUG 2008	1824	1671	1671	46
LCU 1648	SEP 2005-NOV 2008	1117	1126	1117	39
LCU 1665	APR 2005-JUN2008	1206	1198	1198	39
LCU 1666	NOV 2004-APR 2009	1525	1512	1512	54
LCU 1630	MAY 2005-JUL 2008	939	982	939	39
LCU 1646	MAY 2006-APR 2009	811	807	807	55
LCU 1627	JUN 2005-JUL 2008	868	848	848	38
LCU 1634	AUG2004-MAR 2009	1990	2002	1990	56
LCU 1651	AUG 2004-MAR 2009	424	792	424	56

Table 32. Diesel Engine Inspection Report Hours and Schedule Summary (After: Price, 2009)

Month	SR	TOTAL	Month	SR	TOTAL	Month	SR	TOTAL	Month	SR	TOTAL
USS JOUETT (CG 29)						USS HORNE (CG 30)					
FY 1985			FY 1986			FY 1985			FY 1986		
OCT	172,799	635,207	OCT	158,132	294,071	OCT	144,892	381,150	OCT	132,795	293,947
NOV	46,360	205,966	NOV	94,278	176,695	NOV	78,620	204,059	NOV	74,149	172,001
DEC	43,122	141,042	DEC	35,714	97,869	DEC	93,300	199,006	DEC	12,590	105,971
JAN	61,897	188,985	JAN	115,202	288,632	JAN	152,203	446,316	JAN	65,271	201,863
FEB	63,581	143,965	FEB	86,543	251,573	FEB	92,415	153,189	FEB	103,032	173,705
MAR	50,357	97,518	MAR	48,004	153,578	MAR	91,837	206,289	MAR	81,273	210,894
APR	86,318	220,356	APR	154,689	380,957	APR	111,689	573,330	APR	59,778	173,195
MAY	76,721	196,997	MAY	61,147	186,469	MAY	107,140	280,936	MAY	28,452	131,760
JUN	54,321	130,373	JUN	106,953	228,121	JUN	170,762	459,570	JUN	56,156	182,204
JUL	129,469	247,702	JUL	96,161	263,917	JUL	87,817	235,687	JUL	31,869	306,718
AUG	69,645	315,067	AUG	109,495	225,361	AUG	146,055	529,562	AUG	34,989	151,404
SEP	79,153	157,488	SEP	(9,864)	(3,218)	SEP	167,127	335,409	SEP	136,594	493,212
USS STERETT (CG 31)						USS W H STANDLEY (CG 32)					
FY 1985						FY 1985			FY 1986		
OCT	-	261,946	OCT	51,761	263,388	OCT	148,318	299,887	OCT	129,612	374,005
NOV	131,898	314,984	NOV	36,840	187,640	NOV	67,135	188,422	NOV	75,002	207,046
DEC	95,945	197,611	DEC	100,497	592,043	DEC	34,933	72,121	DEC	59,461	117,822
JAN	84,620	294,861	JAN	80,363	695,809	JAN	45,087	158,017	JAN	28,364	103,004
FEB	99,134	287,695	FEB	45,692	196,897	FEB	67,743	207,320	FEB	53,360	289,215
MAR	93,773	302,704	MAR	88,321	234,055	MAR	39,281	195,131	MAR	88,546	236,935
APR	47,227	201,758	APR	81,321	212,930	APR	72,725	216,431	APR	84,582	318,923
MAY	90,538	326,042	MAY	47,689	148,735	MAY	38,590	187,742	MAY	68,034	217,772
JUN	97,702	279,380	JUN	67,323	349,212	JUN	76,303	155,387	JUN	28,783	130,341
JUL	63,625	284,605	JUL	32,097	62,856	JUL	140,977	302,254	JUL	107,865	255,790
AUG	97,146	301,984	AUG	58,900	194,319	AUG	83,966	571,096	AUG	69,655	182,819
SEP	45,470	145,791	SEP	91,666	317,079	SEP	114,800	193,306	SEP	40,935	176,660
USS FOX (CG 33)						USS KNOX (FF 1052)					
FY 1985						FY 1985			FY 1986		
OCT	107,300	242,202	OCT	87,001	190,631	OCT	31,931	92,281	OCT	22,232	140,907
NOV	88,499	221,047	NOV	78,475	247,724	NOV	42,380	98,277	NOV	67,579	134,357
DEC	49,170	180,182	DEC	76,951	130,806	DEC	14,548	40,099	DEC	33,890	61,787
JAN	149,021	432,617	JAN	44,379	227,292	JAN	36,712	93,926	JAN	33,248	76,433
FEB	144,523	319,770	FEB	69,343	155,811	FEB	28,537	114,557	FEB	19,057	59,896
MAR	130,657	188,652	MAR	1,983	29,919	MAR	27,173	94,257	MAR	50,617	134,235
APR	98,448	240,110	APR	38,939	86,687	APR	25,386	220,904	APR	37,239	80,794
MAY	87,196	314,187	MAY	49,863	160,667	MAY	43,369	111,203	MAY	10,594	58,249
JUN	91,873	264,109	JUN	92,590	203,886	JUN	132,896	(2,092)	JUN	510	33,437
JUL	128,146	310,267	JUL	23,989	131,190	JUL	33,847	119,695	JUL	32,259	110,471
AUG	86,544	228,027	AUG	31,098	107,135	AUG		-	AUG	38,869	136,669
SEP	81,005	166,854	SEP	215,648	551,379	SEP		-	SEP	16,505	83,549
USS WHIPPLE (FF 1062)						USS LOCKWOOD (FF 1064)					
FY 1985			FY 1986			FY 1985			FY 1986		
OCT	112,676	198,285	OCT	66,754	142,965	OCT	45,976	113,502	OCT	61,442	201,853
NOV	21,763	45,863	NOV	34,264	77,787	NOV	57,305	80,237	NOV	17,610	52,879
DEC	81,564	380,630	DEC	35,138	45,857	DEC	35,005	71,301	DEC	9,542	29,442
JAN	21,251	89,327	JAN	89,390	156,230	JAN	53,389	151,934	JAN	4,079	45,313
FEB	16,087	67,260	FEB	45,097	100,768	FEB	46,810	192,923	FEB	28,810	62,645
MAR	20,168	59,652	MAR	12,888	32,086	MAR	22,860	55,251	MAR	33,547	76,666
APR	27,791	92,309	APR	24,008	93,819	APR	57,919	152,582	APR	25,683	75,477
MAY	26,141	67,540	MAY	33,405	89,822	MAY	13,056	72,593	MAY	22,849	69,331
JUN	29,004	85,690	JUN	22,812	75,434	JUN	9,265	48,065	JUN	18,644	41,299
JUL	26,415	74,396	JUL	65,219	123,820	JUL	18,405	58,348	JUL	10,890	61,268
AUG	39,602	102,503	AUG	29,567	75,370	AUG	30,424	89,563	AUG	11,378	68,006
SEP	23,900	62,011	SEP	19,774	53,833	SEP	9,239	51,133	SEP	35,810	144,963

Month	SR	TOTAL	Month	SR	TOTAL	Month	SR	TOTAL	Month	SR	TOTAL
USS STEIN (FF 1065)						USS F HAMMOND (FF 1067)					
FY 1985			FY 1986			FY 1985			FY 1986		
OCT	42,427	121,057	OCT	33,930	136,730	OCT	70,319	158,793	OCT	15,699	76,024
NOV	30,707	105,610	NOV	40,861	59,565	NOV	13,919	113,480	NOV	14,315	46,355
DEC	13,761	22,974	DEC	21,807	51,978	DEC	35,624	70,180	DEC	18,371	30,644
JAN	58,135	150,870	JAN	41,255	75,255	JAN	17,001	47,392	JAN	41,361	144,502
FEB	23,958	87,369	FEB	58,740	144,925	FEB	22,786	60,831	FEB	36,975	60,858
MAR	65,807	117,780	MAR	31,339	25,381	MAR	64,043	137,888	MAR	15,323	97,050
APR	30,242	100,911	APR	37,797	60,804	APR	23,142	61,993	APR	11,439	56,247
MAY	13,616	81,421	MAY	47,780	90,667	MAY	20,442	61,614	MAY	14,105	103,304
JUN	24,694	67,176	JUN	14,978	42,147	JUN	29,460	70,669	JUN	33,316	71,909
JUL	5,403	137,302	JUL	27,385	104,743	JUL	24,358	225,793	JUL	33,676	120,968
AUG	52,314	56,480	AUG	43,745	116,307	AUG	40,124	150,787	AUG	31,457	72,382
SEP	69,227	164,159	SEP	39,106	131,319	SEP	96,139	232,663	SEP	57,373	123,570
USS DOWNES (FF 1070)						USS BADGER (FF 1071)					
FY 1985			FY 1986			FY 1985			FY 1986		
OCT	93,445	197,697	OCT	38,574	98,422	OCT	65,664	147,538	OCT	53,825	114,426
NOV	33,049	73,171	NOV	49,085	91,276	NOV	73,085	90,164	NOV	23,730	74,746
DEC	54,872	132,785	DEC	54,949	99,849	DEC	27,785	35,748	DEC	11,996	31,607
JAN	70,461	118,012	JAN	54,380	139,153	JAN	78,163	131,778	JAN	70,438	102,209
FEB	25,156	97,193	FEB	37,100	56,792	FEB	45,903	88,910	FEB	27,640	117,158
MAR	34,902	75,380	MAR	15,130	20,509	MAR	34,813	100,560	MAR	42,859	90,647
APR	45,657	118,939	APR	85,968	132,805	APR	66,833	152,834	APR	21,789	61,014
MAY	10,585	46,591	MAY	7,079	36,486	MAY	34,929	77,990	MAY	57,616	91,793
JUN	24,701	59,346	JUN	(2,943)	(146,997)	JUN	85,960	120,921	JUN	42,587	95,165
JUL	53,269	137,165	JUL	121,300	164,750	JUL	32,834	102,149	JUL	17,950	68,217
AUG	1,880	54,603	AUG	36,574	89,230	AUG	67,107	97,791	AUG	46,380	97,064
SEP	20,829	103,638	SEP	60,058	112,882	SEP	19,822	37,369	SEP	16,932	37,281
USS FANNING (FF 1076)						USS COOK (FF 1083)					
FY 1985			FY 1986			FY 1985			FY 1986		
OCT	53,604	89,587	OCT	55,334	121,529	OCT	17,196	68,150	OCT	39,593	57,928
NOV	38,166	110,265	NOV	33,236	72,845	NOV	22,182	79,817	NOV	60,315	110,767
DEC	43,416	74,051	DEC	20,950	37,799	DEC	29,119	71,790	DEC	12,949	24,800
JAN	67,064	159,480	JAN	39,320	89,675	JAN	43,655	102,453	JAN	27,160	57,945
FEB	50,274	129,255	FEB	38,666	93,795	FEB	22,350	38,802	FEB	36,795	65,674
MAR	40,773	75,720	MAR	24,629	47,785	MAR	33,923	64,888	MAR	15,079	57,993
APR	52,010	139,946	APR	65,494	151,720	APR	55,760	150,972	APR	21,859	89,286
MAY	21,294	66,614	MAY	21,182	83,081	MAY	42,684	147,574	MAY	18,709	33,306
JUN	30,060	72,630	JUN	22,539	49,044	JUN	49,795	97,266	JUN	194,582	684,032
JUL	57,009	125,260	JUL	12,512	69,736	JUL	22,764	93,078	JUL	(176,149)	(629,043)
AUG	22,945	38,385	AUG	27,737	78,883	AUG	79,438	175,226	AUG	76,725	152,433
SEP	19,803	43,854	SEP	12,255	60,671	SEP	60,419	115,299	SEP	43,017	154,435
USS KIRK (FF 1087)											
FY 1985			FY 1986								
OCT	10,933	47,853	OCT	15,589	65,412						
NOV	23,218	52,851	NOV	38,828	94,013						
DEC	31,759	113,387	DEC	6,983	111,133						
JAN	38,048	92,471	JAN	25,932	202,052						
FEB	37,853	76,871	FEB	30,612	84,678						
MAR	31,308	72,966	MAR	17,090	52,055						
APR	24,875	89,596	APR	13,663	63,619						
MAY	22,686	71,229	MAY	14,222	50,410						
JUN	31,194	86,914	JUN	20,079	92,107						
JUL	14,348	84,210	JUL	30,632	73,744						
AUG	33,401	147,505	AUG	12,634	45,114						
SEP	13,647	146,625	SEP	31,500	48,146						

	SR	Total
CG	9,797,248	29,168,989
FF	8,417,699	21,688,746
Total	18,214,947	50,857,735
	Average	35.8%

Table 33. Historical FF and CG SR vs. Total expenditure data (After: Kuker, 1988)

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